M.Tech. CHEMICAL ENGINEERING

Scheme of Instruction & Examination

1/2 M.TECH (CHEMICAL ENGG.) FIRST SEMESTER

(With Effect From 2021-22 Admitted Batch Onwards)

Under Choice Based Credit System

Code No.	Course	Credits	Theory	Tutorial	Lab	Total	Sessional marks	Exam marks	Total marks
CHEM1.1.1	Chemical Reaction Engineering	3	3	1	—	4	30	70	100
CHEM1.1.2	Transport phenomena	3	3	1	—	4	30	70	100
CHEM1.1.3	Elective-I	3	4	—	—	4	30	70	100
CHEM1.1.4	Elective-II	3	4	—	—	4	30	70	100
CHEM1.1.5	Research Methodology & IPR	2	4	—	—	4	30	70	100
CHEM1.1.6	Audit Course–1*	0	2	-	—	2	—	—	—
CHEM1.1.7	Elective lab	2	—	—	3	3	50	50**	100
CHEM1.1.8	Seminar	2	—	—	3	3	100	—	100
	TOTAL	18	20	2	6	28	300	400	700

*To be included as 'Qualified' or 'Not Qualified' in the marks list

**Only internal evaluation.

Elective-I:
1. Petroleum Refinery Engineering-I
2. Process Dynamics and control-I
3. Electrochemical Engineering-I

Elective-II:
1. Corrosion Engineering-I
2. Energy Engineering-I
3. Reaction Engineering-I

Audit Course 1:
1. Yoga for working professionals
2. Organizational Behaviour

1/2 M.TECH (CHEMICAL ENGG) SECOND SEMESTER

(With Effect From 2021-22 Admitted Batch Onwards)

Under Choice Based Credit System

Code No.	Course	Credits	Theory	Tutorial	Lab	Total	Sessional marks	Exam marks	Total marks
CHEM 1.2.1	Computer aided design	3	3	1	—	4	30	70	100
CHEM1.2.2	Process Dynamic and Control	3	3	1	—	4	30	70	100
CHEM 1.2.3	Advanced mass transfer	3	3	1	—	4	30	70	100
CHEM 1.2.4	Elective-III	3	4	—	—	4	30	70	100
CHEM1.2.5	Elective-IV	3	4	—	—	4	30	70	100
CHEM1.2.6	Audit Course–2*	0	2	-	—	2	—	—	—
CHEM 1.2.7	Elective lab	2	—	—	3	3	50	50	100
CHEM 1.2.8	Seminar	2	—	—	3	3	100	—	100
	TOTAL	19	19	3	6	28	300	400	700

*To be included as 'Qualified' or 'Not Qualified' in the marks list

Elective-III:
1. Petroleum Refinery Engineering-II
2. Process Dynamics and control-II
3. Electrochemical Engineering-II

Elective-IV:
1. Corrosion Engineering-II
2. Energy Engineering-II
3. Reaction Engineering-II

Audit Course 2 :
1. Disaster Management
2. Entrepreneurship

2/2 M.TECH (CHEMICAL ENGG) FIRST SEMESTER

(With Effect From 2021-22 Admitted Batch Onwards)

Under Choice Based Credit System

Code No.	Course	Credits	Theory	Tutorial	Lab	Total	Sessional marks	Exam marks	Total marks
CHEM 2.1.1	Elective-V	3	4	—	—	4	30	70	100
CHEM 2.1.2	Elective-VI(Open Elective)	3	4	—	—	4	30	70	100
CHEM 2.1.3	Dissertation (preliminary)	9	—	—	—	—	100	—	100
	TOTAL	15	8	—	—	8	160	140	300

Note: The dissertation shall be evaluated through Viva-voce examination by a committee with HOD, Chairman, Board of Studies and Research guide as members. The marks shall be awarded in the ratio of 30,30 and 40 percent by the members Respectively

Elective-V:
1. Process modelling and Simulation
2. Computational Methods
3. Advanced Engineering Mathematics and Statistics

Elective-VI:
1. Nano Technology
2. Pollution Control
3. Corrosion Engineering

2/2 M.TECH (CHEMICAL ENGG) SECOND SEMESTER

(With Effect From 2021-22 Admitted Batch Onwards)

Under Choice Based Credit System

Code No.	Course	Credits	Theory	Tutorial	Lab	Total	Sessional marks	Exam marks	Total marks
CHEM 2.2.1	Dissertation	16	—	—	—	—	—	100	100
	TOTAL	16	—	—	—	—	—	100	100

Note: The dissertation shall be evaluated through Viva-voce examination by a committee with an external member nominated by University, HOD, Chairman, Board of Studies and Research guide as members. The marks shall be awarded in the ratio of 20, 20, 20 and 40 percent by the members respectively

SYLLABUS

M.TECH. I SEMESTER

CHEM-1.1.1: Chemical Réaction Engineering

(Common for Chemical, MPE, CACE & IPCE)

Objectives:

* To focus on the thermal characteristics of various reactions and the design aspects of non isothermal and adiabatic reactors

* To focus on Heterogeneous data analysis and design

* To focus on CVD reactors

* To study the design aspects of heterogeneous catalytic systems

* To impart the knowledge on mass transfer with reaction in process catalysts

Outcome:

* Enables the students to understand the design aspects of non isothermal and adiabatic reactors

* Enables the students to on heterogeneous data analysis and design aspects of heterogeneous catalytic systems

* Able to derive the rate laws for CVD

* Able to develop the rate laws for heterogeneous fluid solid catalyzed reactions under rate limiting situations.

SYLLABUS

Review of Fundamentals Rate laws and stiochiometry, reactions with phase change (Scope: Chapter 3 of Fogler) Least squares Analysis of rate data: differential reactors: Laboratory reactors (Scope: sections 5.4 to 5.6 of Fogler) Multiple reactions (Scope: Chapter 9 of Fogler).

Isothermal reactor design (Scope: Chapter 4 of Fogler) Batch reactor, PFR, CSTR design. Pressure drop in reactors, Reversible reactions, unsteady state operation of reactors, Simultaneous reaction and separation

Catalysis and catalytic reactors (Scope: Chapter 6 of Fogler) Steps in catalytic reaction: derivation of rate laws, design for gas-solid reactions, heterogeneous data analysis and design; Chemical vapour deposition, catalyst reactivation, moving bed reactions.

Diffusion and reaction in process catalysts (Scope: Chapter 11 of Fogler). Diffusion and reaction in spherical catalyst.

Internal effectiveness factor, falsified kinetics; estimation of diffusion and reaction limited regimes. Mass transfer and reaction in packed bed. Determination of limiting situations from reaction data, CVD reactors.

Non-isothermal reactor design (Scope: Chapter 8 of Fogler), Energy Balance, equilibrium conversion under adiabatic conditions unsteady state operation, multiple steady states.

Learning outcomes:

* Express important concepts in reaction kinetics and classify reactions according to different properties.

* Calculate the reaction rate constant and reaction activation energy using Least squares Analysis of rate data

* Explain

* Explain the criteria used to evaluate the laboratory reactors and solve problems related to multiple reactions

* develop performance equations for different types of reactors using mass balances

* Design different reactors and explains the Simultaneous reaction and separation.

* Develop the rate laws for heterogeneous fluid solid catalyzed reactions under rate limiting situations.

* Develop the expression for concentration profile and effectiveness factor for first order reaction in a spherical pore of a catalyst.

* Explain different mechanisms postulated for adsorption and surface reaction in catalytic reactions.

* Explain the mass transfer and reaction in a packed bed.

* Do design calculations for non isothermal and adiabatic reactors

* Investigate the effect of temperature on reactor design and reaction parameters.

* Calculates the multiple steady states for MFR type reactors

Textbook:

Fogler. H.S: Elements for Chemical Reaction Engineering 2nd Edition, Prentice Hall, New Delhi, 1992.

Reference:

Smith J.M: 'Chemical Engineering Kinetics' 3rd Edition, McGraw Hill, 1981.

CHEM - 1.1.2 : Transport Phenomena

(Common for Chemical, MPE, CACE & IPCE)

Objectives:

* To be able to analyze various transport processes with understanding of solution approximation methods and their limitations.

Outcomes:

* Ability to understand the chemical and physical transport processes and their mechanism.

* Ability to do heat, mass and momentum transfer analysis.

* Ability to analyze industrial problems along with relevant approximations and boundary conditions.

* Ability to develop steady and time dependent solutions along with their limitations.

SYLLABUS

Unit 1: Momentum Transport : 1.1 The Equations of change for isothermal systems. 1.2 Velocity distributions with more than one independent variable. 1.3 Velocity distributions in turbulent flow. 1.4 Inter phase transport in isothermal systems.

At the end of the course, the student will be able to:

* Perform momentum balance for a given system at microscopic scale.

* Solve the governing equations to obtain velocity profile.

* Solve the unsteady state momentum equation to obtain velocity profiles

* Understand the momentum transport under turbulent conditions and can be able to find out the friction factor or drag coefficient for a fluid flow system

Unit 2: Energy Transport : 1.1 The Equations of change for non – isothermal systems. 1.2 Temperature distributions with more than one independent variable. 1.3 Temperature distributions in turbulent flow 1.4 Inter phase transport in non isothermal systems.

At the end of the course, the student will be able to:

* Perform energy balance for a given system at microscopic scale.

* Solve the governing equations to obtain temperature profiles at steady state and unsteady state condition.

* Understand the energy transport under turbulent flow conditions and can be able to find out the heat transfer coefficient.

Unit 3: Mass Transport : 1.1 The Equations of Change for multi component systems. 1.2 Concentration distribution with more than one independent variable. 1.3 Concentration distribution in turbulent flow.

At the end of the course, the student will be able to:

* Perform the mass balance for a given system at microscopic scale and can be able to solve the governing equation to obtain concentration profiles.

* Solve the unsteady state mass balanceequation to obtain concentration profiles

* Understand the mass transport phenomena under turbulent flow conditions.

Textbook:

"Transport phenomena" R. Byron Bird, Warren E. Stewart and E.N. Light foot, Wiley & Sons, Inc., New York.

Reference Books:

1."Fundamentals of Momentum, Heat and Mass Transfer" James R. Welty, Charles E. Wicks and Robert E. Wilson, John Wiley & Sons, Inc., New York.

2. "Boundary – Layer Theory", Dr.H.Sehlichting, McGraw – Hill Book Company, New York.

CHEM-1.1.3: Elective – I

CHEM- 1.1.3 A - Elective-I (Petroleum Refinery Engineering-I)

Objective: The objective of this course is to provide with: Basic concepts of petroleum refinery engineering, refinery process, products, specifications, test methods and design of equipment.

Outcomes: The student will be able to:

* Understand the formation and composition of petroleum and classify important refinery products and their properties.

* Analyze the fractionation of petroleum, treatment techniques, thermal and catalytic process and design of distillation towers.

SYLLABUS

Origin, formation and composition of petroleum: Origin and formation of petroleum, Reserves and deposits of world, Indian petroleum industry, Composition of petroleum.

Petroleum processing data: Evaluation of petroleum, thermal properties of petroleum fractions, important products and properties, test methods.

Learning outcomes:

* Understand the origin and composition of petroleum, deposits of world.

* Classify the petroleum products and test methods.

Fractionation of petroleum: Dehydration and desalting of crudes, heating of crude-pipe still heaters, distillation of petroleum, blending of gasoline.

Learning outcomes:

* Explain the dehydration and desalting of crudes.

* Analyzing crude pipe still heaters and blending of gasoline.

Treatment techniques: Treatment of gasoline, kerosine, lubes, and wax purification.

Learning outcomes:

* Discuss the treatment of gasoline, kerosine and lubes.

* Explain the wax purification.

Thermal and catalytic processes: Cracking, catalytic cracking, catalytic reforming, coking, alkylation process.

Learning outcomes:

* Explain the catalytic cracking and catalytic reforming process.

* Explain the coking and alkylation process.

Design of atmospheric distillation and vacuum distillation towers.

Learning outcomes:

* Design of atmospheric distillation column.

* Design of vacuum distillation column.

Text book:

Petroleum refinery engineering by Nelson.

Reference Books:

1. Modern petroleum refining process by B.K.Bhaskara Rao.

2. Petroleum refining technology by Dr.Ram Prasad.

CHEM- 1.1.3 B - Elective-I (Process Dynamics and Control-I)

Objectives:

The student is equipped with the analytical tools that are required in the actual design and analysis of distillation control systems. Further this subject provides a unified treatment of steady-state and control aspects of distillation operations.

Outcome:

1. The student know different techniques to formulate and solve binary and multicomponent distillation problems along with case studies

2. Knowing of those variables that affect the composition of the products

3. Dynamic mathematical tools used in controller tuning and process-identification techniques would be known.

4. Design and application of advanced control concepts to distillation would be thoroughly understood.

SYLLABUS

Unit 1 : Overview of steady state distillation concepts.

Unit 2 : Distillation control concept - Controlled variables in distillation - Basis for distillation control strategies - Dynamic Modelling & Simulation.

Unit 3 : Process identification - Frequency response and Controller tuning - Pairing and interaction in distillation.

Unit 4 : Feed forward control - Cascade and parallel cascade control - Dead time compensation.

Unit 5 : Inferential control and model algorithmic control.

Textbook ***:***

Distillation Dynamic and Control - Pradeep B., Deshpande, ISA, Tata McGraw Hill Co. Ltd.

Reference:

Design of Distillation Column Control Systems -Luyben and Shunta ISA. Tata McGraw Hill Co.

Learning Outcomes

UNIT-I : 1. After completing this unit, the students will be able to choose a key component for the calculations involved in the multicomponent distillation operation. 2. At the end of this unit, the students can predict vapor-liquid equilibrium data by using a suitable excess Gibbs free energy equation.

UNIT-II : 1. The students will be able to identify the variables that would be useful for controlling the distillation columns. 2. For effective control of distillation columns best control strategy would be selected among various alternatives.

UNIT-III : 1. By studying this unit, the students will be able to predict the transfer function from response of different forcing functions. 2. Controller tuning parameters can be predicted for any given control system after completion of this unit.

UNIT-IV : 1. Selection of suitable advanced control action would be possible for a given situation once the student completes learning this unit. 2. The students become familiar in compensating the dead time that exists in the distillation columns.

UNIT-V : 1. The student can estimate the response of a distillation column by applying internal model control. 2. Application of appropriate mathematical models can be examined for superior control of distillation columns.

Textbook :

Distillation Dynamic and Control - Pradeep B., Deshpande, ISA, Tata McGraw Hill Co. Ltd.

Reference:

Design of Distillation Column Control Systems -Luyben and Shunta ISA. Tata McGraw Hill Co.

CHEM- 1.1.3 C - Elective-I (Electrochemical Engineering-I)

OBJECTIVES:

* To enable the basic principles of electrochemistry, electrochemical devices, electro active materials used in such devices, and case studies of batteries.

* To enable the clean energy needs and demands especially in the electrochemical power generation sector; and to become educators, practicing engineers, and national leaders in electrochemical energy conversion and storage.

* To enable the integrated skills in fundamentals of electrochemistry (e.g.; chemistry, physics, mathematics, thermodynamics, and chemical kinetics) and electrochemical engineering applications (batteries, solar, flow and fuel cells, electrochemical synthesis and corrosion) to ensure successful career opportunities and growth within electrochemical power generation industries and academia.

* To enable the students in energy related programs such as clean power generation and future green technologies.

OUTCOMES:

* The student would know how to solve the problems relating to the production, storage, distribution and utilization of electrochemical energy and the associated environmental issues. And he would know integration of electrochemical principles and materials science for application in modern electrochemical devices.

* The student would know design and conduct experiments, acquire data, analyze, interpret data, solve practical and complex problems on a variety of electrochemical devices such as batteries, solar cells, flow and fuel cells and integrate the professional, ethical, social and environmental factors in electrochemical engineering and understand the impact of these factors on global energy issues.

SYLLABUS

Introduction:

Unit I : Basic Concept: Mechanism of Electrolysis, Laws of Electrolysis, Curent and Voltage Efficiency - Electrolytic dissociation, Coulometers, Ionic conduction. Electrolytic conductivity, Absolute ionic velocities, ionic mobilities, Transference Nos. Modern Ionic Theory, Ionic activity Degree of dissociation. Ionic Atmosphere Time of relaxation and relaxation effect, Electrophoretic effect - Debye - Huckel Onsager equation of conductance (Derivation is not required) and its validity.

* Able to understand the concept and applications of Laws of Electrolysis.

* Able to understand the importance and construction of Coulometers.

* Able to understand about Transference Nos.

* Able to understand Degree of dissociation.

Unit II: Thermodynamics I: Chemical Potential and Free Energy changes. Cell and Electrode potentials. Thermodynamics of Electrode potentials - Nernst Equation. Equilibrium Constant, Arbitrary Zero of potential, EMF series and their limitations Activity Coefficient of and their evaluation, Liquid Junction potentials, Concentration Cells - Reference Electrodes.

* Able to understand the concept of Chemical Potential and Free Energy changes.

* Able to understand how to calculate cell electrode potential.

* Able to understand the application of Nernst Equation.

* Able to understand how to measure Junction potential.

Unit III : Thermodynamics II : Electrode Kinetics, Role of Interface, Electric Double Layer and its capacitance - Irreversible Electrode processes - Irreversibility, Tates of Electrode Processes. Electrode Kinetics Model, Cathodic Hydrogen evolution, Depolarisation - Overpotential, Tafel Equation, Ohmic or resistance Over potential, Concentration overpotential, Oxygen Evolution reaction and Decompostion potential, Ionic Transport by Migration, Diffusion and Convection - Mass transfer.

* Able to understand Electric Double Layer theory.

* Able to understand the concepts of Depolarisation and Overpotential.

* Able to understand importance of Tafel Equation.

Unit IV : Kenetics of Corrosion Processes and Evans Diagrams : Electrokinetic phenomenon - Straming potential, zeta potential and Electro - Osmosis, Electrophoresis, Dorn Effect.

Measurements and Systems Analysis : Conductivity measurements - Conductometric analysis - Titrations, Measurements of pH, potential - potentiometric titrations, Polarography Electrogravimetry, Coulometry. Current Distribution in a cell. Rotating Disc Electrode, Rotating Cylinder electrode, Rough Surface Electrode Limiting Current Technique.

* Able to understand the importance of Evans Diagrams.

* Able to understand the concepts of Osmosis and Electrophoresis.

* Able to understand the importance of Conductometric analysis – Titrations.

* Able to understand about potentiometric titrations.

Unit-V: Potential relations in corrosion cells potentials, pH diagrams in corrosion.

Corrosion theory : Manifestation of corrosion, bases of electrochemical corrosion, amount and intensity of corrosion, Eight forms of corrosion : Uniform attack, Galavanic corrosion, crevice corrosion,Pitting, inter granular corrosion. Selective leaching, stress corrosion cracking. Conditions leading to pitting attack., environmental factors, hydrogen damage. Corrosion inhibition and prevention : Domestic water supplies, recirculating water systems, corrosion inhibitors, Inhibitors for acid pickling, vapor phase inhibitors. Coatings and paits: Phosphating, Protective metal coatings; cathodic protection and corrosion of buried structures.

* Able to understand the different forms of corrosion.

* Able to understand the preventive techniques of corrosion.

* Able to understand the concepts of Protective metal coatings.

* Able to understand the application of cathodic protection of buried structures.

Textbooks:

1. An Introduction to Electrochemistry by Samuel Glasstone, D. Van Nostrand Company Inc princeton, Affiliated East-West press Pvt. Ltd.

2. Electrochemistry - Principles and Applications by Edmund C. Fotter Oliver Hume Press Ltd., London.

Reference Books:

1. Electrochemical Engineering, Principles, by Geofferey Prentice, The Johns Hopkins University, Prentice Hall, Englewood Cliffs, New Jersy, 07632.

2. Electrochemistry - Bookris and A.K.Reddy.

3. Electrochemical Engineering by C.L.Mantell.

4. Principles of Electrochemical Engineering by L.W.Shemilt.

5. Chemical Engineering Development Centre, Indian Institute of Technology, Madras 600 036.

6. Fontanna and Grene 'Corrosion Engineering'.

CHEM-1.1.4: Elective –II

CHEM-1.1.4 A - Elective-II (Corrosion Engineering-I)

Common for M.Tech (Chemical, MPE, IPCE, CACE & Biotechnology)

Objectives : The main objectives are to provide:

1. Basic aspects of electrochemistry relevant to corrosion phenomena,

2. Importance and forms of corrosion.

3. Knowledge on corrosion rate expressions and measurement techniques.

4. Knowledge on factors influencing corrosion of iron and steel exposed to atmospheric, soil and aqueous medium.

5. Basic knowledge on remedial measures for corrosion.

Outcome: At the end of the course, the student will be able to

1. Acquires knowledge on basic principles of electrochemistry, importance of corrosion.

2. Predict whether corrosion will occur for a particular environment.

3. Estimate corrosion rates and analyze.

4. Identify the type of corrosion and propose viable remedial measures.

SYLLABUS

Basic Concepts and Outlines of Electrochemistry: Fundamentals of Electrochemical reactions, Faraday's Laws Electrolytic and ionic conductance, ionic mobility's, Transport Nos. Galvanic Cell and Electrolytic cells.

Definition and importance of corrosion, Dry cell, analogy, Corrosion Cells, Types of Corrosion Cells- a) Dissimilar electrode cells b) Concentration cells such as a salt concentration cells, differential aeration cells c) differential Temperature cells. Corrosion Rate Expresions - mdd, ipy, cpy, mpy, etc.

LO1: Choose a specific cell for a given situation

LO2: Identify the type of corrosion cell that will form in that particular environment Corrosion Tendency and Electrode Potentials: Free Energy changes, Development of Nernst Equation for calculation of Half-cell potentials, Hydrogen electrode, Spontaneity of a reaction, Reversible cells and potentials – convention of Sign and calculations of EMF from standard Equilibrium potentials., EMF Series and Galvanic series, Reference Half Cells – Calomel, Silver-Silver Chloride and Saturated Copper-Copper Sulphate Half Cells. Pourbaix Diagram for Iron, Aluminum and magnesium, limitations of pourbaix diagrams.

LO3: Predict the tendency of corrosion to occur

LO4: Identify the corrosion zones based on pH of media Polarization and Corrosion Rates: Polarization and a Polarized Cell, Causes of Polarization – Concentration Polarization, Activation Polarization and IR drop. Hydrogen Over potentials, combined polarization and Mixed potential theory. Tafel Slopes and Tafel Equation. Graphical method of expressing Corrosion Reactions (Polarization diagrams/Evans diagrams), Derivation of Stern-Geary Equation, Influence of Polarization on Corrosion rates.

LO5: Derive the equations for estimating corrosion rates

LO6: Evaluate and Analyze data for corrosion rates Passivity: Characteristics of Passivation, Flade potential, behavior of passivators, transpasivity, Theories on Passivity. Forms of Corrosion: Uniform attack,

Galvanic Corrosion, Crevice Corrosion, Pitting, Intergranular Corrosion, Selective Leaching, Erosion Corrosion and Stress Corrosion. Hydrogen damage. Factors influencing, mechanisms and prevention techniques for all forms of corrosion. Calculation of Corrosion rates using weight lost method and Polarization data. Electrochemical Impedance Spectroscopy.

Effect of Dissolved Oxygen (Air saturated Water, High Partial Pressure of Oxygen and Anaerobic bacteria), Temperature, pH, Galvanic coupling, velocity, dissolved salts concentration. Wet and dry corrosion.

LO7: Identify the type of corrosion

LO8: Recommend proper remedial measures

Textbooks :

1. Corrosion and Corrosion Control by Herbert, H. Uhlig John Wiley and Sons Inc., New York.

2. Corrosion Engineering by Mars F Fontana, McGraw Hill.

3. An Introduction to Electrochemistry by Samuel Glass stone, Affiliated East West Press Pvt. Ltd.,

Reference Books :

1. Corrrosion Volumes 1 & 2 by L.L. Shrier, Newnes - Butter-worths, London.

CHEM- 1.1.4 B - Elective-II (Energy Engineering-I)

Objectives:

To lean overview of solar radiation and it's potential for collection to meet the energy needs of mankind and potential for solar energy option. To learn measuring techniques of solar radiation and its compilation.

To learn various design and operational aspects of solar energy collection and storage.

To learn the design and operation of solar energy appliances like liquid flat plate collectors, Solar Air Heaters, Thermal energy storage, Thermal energy storage, Solar Pond, Solar thermal power generation.

To learn theory and application of Photovoltaic cells

Outcome:

The student learns collection and design of various kinds of equipment operated on solar energy. The student learns principles and practice of Photo voltaic cells.

SYLLABUS

The Solar Energy option : Thermal conversion – collection and storage Thermal applications – photovoltaic conversion – wind energy – Energy from Bio – mass – ocean thermal energy conversion.

Solar Radiation : Solar Radiation outside the earths – atmosphere Solar radiation at the Earth's surface – Instruments for measuring Solar Radiation – Solar Radiation data – Solar Radiation Geometry Empirical equations for predicting the availability of Solar Radiation – Solar radiation on tilted surface.

Liquid flat – Plate Collectors : Components of liquid flat plate – various types of collectors – Performance Analysis – Transmissivity – Absorptivity product – Overall loss coefficients and heat Transfer correlations – Collector efficiency heat removal factors – effect of various parameters on performance. Transient Analysis – Testing procedures.

Solar Air Heaters : Various types of solar Heaters – Performance Analysis of a conventional Air Heater – Testing procedures – Concentrating collectors – various types of concentrating collectors cylindrical and parabolic collectors – General receiver collectors.

Thermal energy storage : Sensible heat storage – Latent heat storage – Thermochemical storage Solar Pond Description – Performance analysis – Experimental studies – Operational problems.

Solar Air Conditioning and Refrigeration : Heat pump cycle – Coefficient of performance of the heat pumps – solar air-conditioning with absorption – Refrigeration system (Ammonia water and lithium bromide – water systems).

Solar thermal power generation : Thermal and direct electricity generation – Major sub-stations of a solar thermal power plant, Examples of installed systems – Concentration ratio. Temperature and efficiency concepts – Solar farm and tower – Economics.

Photovoltaic Energy Conversion : Photovoltaic Energy Conversion Fundamentals – band theory of solids – Physical processes in a solar cell – Solar cell with light incidence – Solar cell module – Silicon Solar Cells – Copper Sulphate / Cadmium sulphide Solar Cells.(Banasal et at.,chapters 9;Taylor, chapters 6, pages 256-298.

Text Books:

1. Solar Energy: Principles of thermal collection and storage by S.P. Sukhatme, Tata McGraw Hill, New Delhi 1984 (Chapters 2 to 8)

2. Renewable energy sources and conversion technology by N. K. Bansal, M. Kleemann, Michael Mcliss, 1990 (Chapters 2 – 9).

CHEM- 1.1.4 C - Elective-II (Reaction Engineering-I)

Unit I : (Scope : J.M. Smith : Chapter 7): Heterogeneous Processes, catalysis, and absorption: Global Rates of Reaction - Types of Heterogeneous Reactions - The nature of catalytic Reactions - The Mechanism of catalytic Reactions - Surface Chemistry and Absorption - Absorption Isotherms - Rates of Absorption.

Unit II (Scope : J. M. Smith: Chapter 8 : Solid Catalysts: Determination of surface area - Void Volume and solid density - Fore volume distribution - Theories of Heterogeneous Catalysis - Classification of catalysts - Catalyst Preparation - Promoters and Inhibitors Catalyst Deactivation (Poisoning).

Unit III: (Scope: J.M. Smith : Chapter 9): Rate equations for fluid - Solid Catalytic Reactions: Rates of adsorption, Desorption, Surface Reaction - Rate equations in terms of Fluid phase concentrations at the catalyst surface - Qualitative analysis of rate equation - Quantitative inter pretation of Kinetic data - Redox Rate equations.

Unit IV: (Scope : Octave Levenspiel : Chapter 15) : Deactivating Catalysts : Mechanism of Catalyst Deactivation - The ratre of equation - The rate of equation from experiment - Batch - solids: Determining the rate for Independent Deactivation Batch - solids : Determining the rate of parellel, series or side - by - side Deactivation - Flowing solids experimental Reactors - Finding the Mechanism of Decay from experiment Design.

Unit V: (Scope : J. M. Smith : Chapter 10) : External transport Processes in Heterogeneous Reactions: Fixed bed reactors - The effect of physical processes on observed rate of reaction - Mass and Heat transfer coefficients (fluid particle) in packed beds - Quantitative treatment of external transport effects - Stable operating conditions - Effect of external transport Processes on selectivity. Fluidised bed reactors - Particle - fluid Mass and Heat transfer Slurry Reactors - Mass transfer coefficients: Gas bubble to liquid (K_1) - Mass transfer coefficients: Liquid to particle

(K_c) - The effect of mass - transfer on observed rates Trickle - Bed reactors - mass transfer coefficients: Gas to liquid ($K_1 a_g$) - Liquid to particle ($k_c a_c$) - Calculation of global rate.

Text Books:

1. Smith. J.M., " Chemical Engineering Kinetics", McGraw Hill book Company, New Delhi (Third Edition) 1981.

2. Octave Levenspiel, " Chemical Reaction Engineering" , Wiley Eastern Limited - Second Edition - 1972.

Reference Books :

1. Thomas, J.M. And Thomas, W.J. " Introduction to the Principles of Heterogeneous Catalysis". Academic Press Inc., New York 1967.

2. Carbnerry, James, J., " Chemical and Catalytjic Reaction - Engineering", McGraw - Hill, Engineering Series.

CHEM 1.1.5: RESEARCH METHODOLOGY AND IPR

Unit 1: Meaning of research problem, Sources of research problem, Criteria Characteristics of a good research problem, Errors in selecting a research problem, Scope and objectives of research problem. Approaches of investigation of solutions for research problem, data collection, analysis, interpretation, Necessary instrumentations

Unit 2: Effective literature studies approaches, analysis, Plagiarism, Research ethics,

Unit 3: Effective technical writing, how to write report, Paper, Developing a Research Proposal, Format of research proposal, a presentation and assessment by a review committee

Unit 4: Nature of Intellectual Property: Patents, Designs, Trade and Copyright. Process of Patenting and Development: technological research, innovation, patenting, development. International Scenario: International cooperation on Intellectual Property. Procedure for grants of patents, Patenting under PCT.

Unit 5: Patent Rights: Scope of Patent Rights. Licensing and transfer of technology. Patent information and databases. Geographical Indications.

Unit 6: New Developments in IPR: Administration of Patent System. New developments in IPR; IPR of Biological Systems, Computer Software etc. Traditional knowledge Case Studies, IPR and IITs.

References:

1. Stuart Melville and Wayne Goddard, "Research methodology: an introduction for science

2. & engineering students'"

3. Wayne Goddard and Stuart Melville, "Research Methodology: An Introduction"

4. Ranjit Kumar, 2nd Edition , "Research Methodology: A Step by Step Guide for beginners"

5. Halbert, "Resisting Intellectual Property", Taylor & Francis Ltd ,2007.

6. Mayall , "Industrial Design", McGraw Hill, 1992.

7. Niebel , "Product Design", McGraw Hill, 1974.

8. Asimov , "Introduction to Design", Prentice Hall, 1962.

9. Robert P. Merges, Peter S. Menell, Mark A. Lemley, " Intellectual Property in New

10. Technological Age", 2016.

11. T. Ramappa, "Intellectual Property Rights Under WTO", S. Chand, 2008

CHEM 1.1.6 A: Audit Course-1 (YOGA FOR WORKING PROFESSIONALS)

Course objectives:

1. To make the student understand various practices of yoga and yoga diet.

2. To make the student be familiar with various asanas and other associated practices.

3. To make the student appraise the holistic benefits of yoga

4. To make the student identify a therapeutic solution for common health issues.

5. To make the student experience the pranahuti aided meditation.

Course outcomes:

1. The students will discover the importance of yoga for leading a disciplined way of life.

2. The students would improve their wellness by adapting various yogic practices in their day to day life.

3. The students would perceive the holistic benefits of yoga

4. The students can judge the causes of common diseases and can recommend therapeutic solutions based on yogic practices

5. The student can compare the placebo meditation and meditation with pranhuti.

Unit-I: Introduction to Yoga : The Origins of Yoga – Definitions - Concepts - Aims and objectives of Yoga - Yoga is a Science and Art - Ideal Practice of Yoga in the new millennium. Streams of Yoga - Karma Yoga - Bhakti Yoga - Jnana Yoga - Raja Yoga (Astanga Yoga) - Hatha Yoga - Yoga and Diet - - Yoga Disciplined way of life. Difference between Yogasanas and Physical Exercises.

Learning outcomes:

1. After completing this unit, the students will be able to recognize the differences between yogic practices and physical exercises.

2. At the end of this unit, the students will be able assess the relevance of yogic practices for holistic wellness in the contemporary times.

Unit-II: Yogasanas with practical : Loosening the joints- Joint freeing series, Suryanamaskar, Tadasana, Trikonasana, Artha chandrasana, Danurasana, Utkatasana, Dandasana, Pavanamuktasana, Hamsasana, Arthakati chakrasana, Artha chakrasana, Janusirasasana, Vajrasana, Makarasana, Padmasana, Sukhasana, Natrajasana, Savasana. Introduction to Kriyas, Pranayamas, Bandhas and Mudras.

Learning outcomes:

1. The students will be able to demonstrate some selective yogasanas.

2. The students will be able to appraise the importance of allied yogic practices such as pranayama, mudras, bandhas and kriyas.

Unit-III: Physiological benefits of Yoga : Physiological Benefits of Asanas and Pranayama – Chest Cage – Regulation of Breathing – Types of Breathing. Physiological Benefits of Bandhas – Mudras – Kriyas - Meditation – Nadis – Chakras – Kundalini shakti – Psycho-neuro Immunology. Role of Yoga on Psychological Qualities and Psychological Disorders.

Learning outcomes:

1. By studying this unit, the students will be able to value the physiological benefits of yoga practices.

2. The students will be able to support the role of yoga in the treatment of psychological disorders at the end of this chapter.

Unit-IV: Introduction to Yoga Therapy : Essence and Principles of Yoga therapy- Physiology and Pathology in the yoga – Shatra- koshas – doshas- Granthis – Pancha prana – Application of Yoga and its types- Methodology in Yoga Therapy – Factors (Heyam, Hetu, Hanam and Upayam) - Methods (Darsanam, Sparsanam, Prasnam, Nadi, Pariksa) Examination of Vertebra, joints, Muscles, Abdomen and Nervous system and therapeutic applications – Modification of yogic practices for Human Systems- Yogic diet.

Learning outcomes: 1. At the end of the unit, the students become familiar in assessing the health of an individual. 2. After completing this unit, the students can recommend appropriate yoga therapy for health problems faced by an individual.

Unit-V: Meditation : (The student has to maintain a diary to record his observations during meditation. This diary will help him to understand the extent of his progress) Meaning and Concept of Meditation – Need of meditation- techniques of meditation-Tools of meditation-Advantages of Meditation- Experience of meditation- Obstacles. Sahaj Marg Meditation, Heartfulness movement. Elements of sahaj marg meditation: Prayer, cleaning, sitting, satsang, universal prayer and suggestions. Ten maxims of sahaj marg.

Learning outcomes:

1. The student will be well versed in the benefits of meditation at the end of the unit.

2. The student can experience the difference in normal situation and meditative condition after experiencing pranahuti aided meditation.

Reference books

1. George Feuerstein: The Yoga Tradition (Its history, literature, philosophy and practice).

2. Georg Feuerstein. The Psychology of Yoga: Integrating Eastern and Western Approaches for Understanding the Mind.

3. Swamy Satyananda Saraswathi: Asana, Pranayama, Mudra, Bandha (India: Yoga Publications Trust, Munger, Bihar).

4. Swami Sivananda **:** Practice of Yoga (The Divine Life Society, Shivananda Nagar.P.O.,U.P. Himalayas, India).

5. Krishna Raman: A Matter of Health (Integration of Yoga and western medicine for prevention and cure) (Chennai East West Books(Madras) Pvt. Ltd.,1998.

6. Bhavanani, A.B. (2011): Application of Yoga Concept in the Health Improvement. In: P.Nikic, ed.

7. Ram Chandra, Complete works or Ram Chandra (Babuji) Vol. I, Sri Ram Chandra Misssion, SPHT, Calcutta.

CHEM 1.1.6 B- Audit Course -I Organizational Behavior

UNIT-I: Organizational Behavior: Concept of Organization - Concept of Organizational Behavior - Nature of Organizational Behavior - Role of Organizational behavior - Disciplines contributing to Organizational Behavior.

UNIT-II: Motivation: Definition - Nature of Motivation - Role of Motivation - Theories of Motivation: Maslow's Need Hierarchy Theory, Herzberg's Motivation Hygiene Theory and McGregor's Theory X and Theory Y.

UNIT –III: Group Dynamics: Meaning - Concept of Group - Types of groups -Formal and Informal groups - Group development - Group cohesiveness and factors affecting group cohesiveness.

UNIT-IV: Leadership: Concept of Leadership - Difference between Leadership and Management - Importance of Leadership - Leadership styles: Autocratic leadership, Participative leadership and Free Rein leadership.

UNIT-V: Communication: Meaning - Communication Process - Forms of communication: Oral, Written and Non- Verbal communication - Direction of communication: Downward, Upward and Horizontal communication.

UNIT-VI: Organizational conflicts: Concept of conflict - Reasons for conflict - Types of Conflict: Intrapersonal conflict, Interpersonal conflict, Intragroup conflict, Intergroup conflict, Inter organizational conflict - Conflict management.

UNIT –VII: Organizational Change: Nature - Factors in Organizational change -Planned change: Process of planned change - Resistance to change: Factors in resistance to change - Overcoming resistance to change.

Text Books.

1.L.M.Prasad: Organizational Behavior, Sultan Chand & Sons, New Delhi -110002

2.K. Aswathappa: Organizational Behavior, Himalaya Publishing House, New Delhi

Reference Books.

1. Stephen Robbins: Organizational Behavior, Pearsons Education, New Delhi.

II SEMESTER

CHEM –1.2.1: COMPUTER AIDED DESIGN

(Common for Chemical Engineering & CACE)

The objectives of this course are to provide the student with:

· a basic understanding of the fundamentals of executive program, executive program aided simulation, unit computations, information flow diagram, encoding of information flow diagram, simulation of a simple plant, applications of simulation

· knowledge to write algorithm and programs for various fluid flow problems, pressure drop in two phase flow, pipeline network calculations

· knowledge to write algorithm and programs for rating and design calculations heat exchanger, condenser, reboiler, flash calculations, distillation column, gas absorption column, crosscurrent and counter current extraction, analysis of data in a reactor, extent of reaction, ideal reactors, semibatch reactor, packed bed reactor and fluidized bed reactor

Outcome:

· Enables students to learn the basics of computer aided design, executive program aided simulation and its applications

· Students will be able to write/develop unit computations (programs) for fluid flow, mass transfer, heat transfer and reaction engineering problems

SYLLABUS

Unit I : Introduction on simulation and importance of simulation for chemical process industries Introduction to computer aided design- executive program. coding of chemical process flow chart. Information flow diagram, unit computations, developing a description of information flow diagram, information flow diagram to numerical form, planning calculations, finding recycles, planning calculations for recycle set.

Unit II : Mass transfer operations: introduction, distillation- simple binary distillation, Multicomponent flash calculations, multi component stage wise calculations, Gas absorption- absorption and stripping in plate columns, absorption in packed columns, Liquid extraction- single stage contact, cross current extraction, counter current extraction

Unit III : Flow of fluids in pipes: Introduction, flow of Newtonian fluid in a pipe- incompressible fluid flow, sizing of pipes, Pressure drop in compressible fluid flow, flow of non Newtonian fluids- Bingham plastic fluid, Power law fluid, generalized Reynolds number, Sizing of pipes for non Newtonian fluid How, Pipe network calculations, two phase flow systems- gas liquid flow, solid liquid flow, gas solid flow.

Unit IV : Heat transfer: Introduction, shell and tube exchangers without phase change- tube side heat transfer coefficients, shell side heat transfer coefficients, pressure drop in shell and tube heat exchanger, condensers, reboilers

Unit V : Chemical reaction Engineering: Introduction, extent of reaction, chemical reaction equilibrium- independence of reactions, calculation of chemical equilibrium, Analysis of rate data - Integral method, differential method, nonelementary reactions, temperature dependence of rate constant, Ideal reactors- batch reactor, continuous stirred tank reactor, plug flow reactor, semi batch reactor, Temperature effects in homogeneous reactors- ideal batch reactor, CSTR, PFR, Heterogeneous system- analysis of rate data, fixed bed reactor, catalyst deactivation.

Prescribed book:

1. Chemical Process calculations by Raghu Raman, Elsevier applied science publishers, London-New York

2, Simulation of sulphuric acid plant by Crowe

3. Product and process design principles- synthesis, analysis and evaluation by Warren Sieder, J.D. Sieder, Daniel R. Lewin

CHEM-1.2.2: Process Dynamics & Control

(Common for MPE, CACE & IPCE)

Objectives :

The main purpose of teaching Process Dynamics & Control for first year postgraduate students is to take the student from basic mathematics to a variety of design applications in a clear, concise manner. This course is focused on the use of the digital computer in complex problem solving and in process control instrumentation. For chemical engineering problem solving students need more advanced mathematical preparation like partial differential equations, linear algebra and Fourier series all are introduced in this course.

Outcome:

* Able to know the sampled data control systems consists of sampling and advanced mathematical model Z- transforms.

* Able to describe the process in which the flow of the signals is interrupted periodically like in chromatograph.

* Able to calculate the open loop response of a sampled data system and can develop a pulse transfer function that is the counterpart of the transfer function for continuous systems.

* Able to know the sophisticated instruments used for the analysis of water and air pollutants, The student should have knowledge to design the equipment used for the abatement of these pollutants.

* In a position to modernize the solid waste management and the student must be in a position to get awareness on accidents that are occurring in industries during handling, storage, and manufacturing of chemicals, remedial measures to arrest the accidents immediately.

SYLLABUS

Unit-1 : Review of time domain, Laplace domain and frequency domain dynamics of process and control system.

Learning outcomes

* Able to know the sampled data control systems consists of sampling and

* Able to solve the problems related to Laplace domain and frequency domain dynamics of process and control system.

Unit-2 : Sampled data control system – sampling and Z–Transforms , open loop and closed loop response, Stability.

Learning outcomes

* Able to solve the problems related toSampled data control system – sampling and Z–Transforms ,

* Able to calculate the open loop response of a sampled data system and stability

Unit-3 : State space methods – representation of physical systems – transfer function matrix – Multivariable systems – Analysis and control.

Learning outcomes

* Able to solve the problems related toState space methods – representation of physical systems and Student can develop a pulse transfer function that is the counterpart of the transfer function for continuous systems.

* Able to solve the Design Multivariable control systems – Analysis and control.The student should have knowledge to design the equipment used for the abatement of these process control systems.

Unit-4 : Non linear control –examples of non linear systems – Methods of phase plane analysis.

Learning outcomes

* Able to solve the problems related toNon linear control systems

* Able to solve the problems related toexamples of non linear systems and also develops Methods of phase plane analysis.

Unit-5 : Control of heat exchangers, distillation columns and Chemical Reactors.

Learning outcomes

* Able to solve the problems related toControl of heat exchangers, distillation columns and

* Able to solve the problems related toChemical Reactors.

Textbooks:

1. Process system Analysis and control, 2nd edition, Donald R Coughanower and Koppel.

2. Automatic process Control by Peter Harriot.

3. Process Modeling, Simulation and control for Chemical Engineers by W.L. Luyben.

CHEM- 1.2.3 - ADVANCED MASS TRANSFER

Objectives:

* To develop skills in the process design of mass transfer operations

* To understand problems involving mass transfer using the principles of material and energy balances.

Outcomes:

* Ability to design process equipment for various mass transfer operations.

* Ability to use equations of change for multi-component systems.

* Ability to solve problems of mass transfer in laminar and turbulent regimes.

* Ability to solve problems of interphase transport in non-isothermal systems.

Syllabus

Chapter 1: Flux Definition

* Mass and molar transport by convection

* Summary of mass and molar fluxes

* Fick's law

Chapter 2: Differential Equations of Mass transfer

* Differential equation for mass transfer

* Boundary conditions

Chapter 3: Molecular diffusivities

* Diffusivities in gases

* Diffusivities in liquids

Chapter 4: Molecular diffusion

* Steady state molecular diffusion

* Steady-State Equimolal counter diffusion in gases

* Steady state Equimolal unidirectional diffusion in gases

* Molar diffusion in liquids

* Diffusion through a stagnant gas film

* Diffusion with a moving interface

* Diffusion through a Nonisothermal Spherical film

* Diffusion with a Heterogeneous Chemical reaction

* Diffusion with a slow Heterogeneous Chemical reaction

* Diffusion with a homogeneous Chemical reaction

* Unsteady state diffusion in a sphere

* Unsteady state diffusion in a slab

* Unsteady state diffusion in a Cylinder

Chapter 5: Mass Transfer coefficients

* Individual Mass transfer coefficients

* Overall Mass Transfer coefficients

* Mechanism of Mass transfer

* The two-film theory

* The penetration theory

* The theory of penetration with Random surface renewal

Chapter 6: Mass transfer in Laminar Flow

* Mass transfer in the laminar boundary layer on a flat plate (Integral Solution)

* Mass transfer in laminar Natural convection on a vertical plate

* Mass transfer in a falling liquid film in a laminar flow

* Mass transfer between a gas phase and a falling liquid film (gas absorption)

* Mass transfer between an inclined plate and a falling liquid film (Solid dissolution)

* Gas absorption with rapid reaction

Chapter 7: Mass Transfer in turbulent flow

* Mass transfer in the turbulent boundary layer on a flat plate

* Mass transfer in turbulent Natural convectionon a vertical plate

* Mass transfer between inclined plate and a falling liquid film in turbulent flow

* Anologies between momentum, heat and mass transfer

* Reynolds analogy

* Prandtl analogy

* Von Karman analogy

* Analogies in terms of j factor

Text Books:

1. A H P Skelland, Diffusional Mass transfer, John Wiley and Sons (1974)

Reference Books:

1. R B Bird, W E Steward and E N Lightfoot, Transport Phenomena, 2nd Ed., John Wiley and Sons (2002)
2. J R Welty, C E Wicks, R E Wilson and G. Rorrer, Fundamentals of Momentum, Heat and Mass transfer, 4th Ed., John Wiley and Sons (2001)

CHEM-1.2.4 - Elective-III

CHEM-1.2.4 A – ELECTIVE-III (Petroleum Refinery Engg-II)

Objective: The objective of this course is to provide with the**:**

* Production process for the manufacture of C1 to Aromatic Compounds.

* Design aspects for designing of various equipment used in the process.

Outcomes: The student will be able to:

* Understand the process and mechanism of various production process of C1 to Aromatic compounds.

* Design various equipment used in the production process.

Syllabus

Petrochemical industry in India, Raw materials for petrochemicals, refinery process for petrochemical feed stocks, pyrolysis for petrochemical feed stocks, separation of hydrocarbons.

Learning outcomes:

* Choose various petrochemical feed stocks for manufacture of petrochemical compounds.

* Discuss various refining process for the manufacture of petrochemical feed stocks. Petrochemicals from C1 fractions: Synthesis gas, Methanol, Formaldehyde, Chloromethanes, Hydrogen cyanide, Methyl amines.

Petrochemicals from C2 fractions: Polyethylene, Ethanol, Ethylene Oxide, Acetaldehyde, Ethyl Benzene, 1-2 dichloroethane, Vinylchloride, Vinylacetate, Ethanol amines.

Learning outcomes:

* Design and evaluate a process for the manufacture of C_1 fractions.

* Design and evaluate a process for the manufacture of C_2 fractions.

Petrochemicals from C3 fractions: Isopropanol, Acetone, Propylene oxide, Acrylonitrile, Cumene, Isoprene, Oligomers and co-oligomers of Propylene.

Petrochemicals from C4 fractions: Butadiene, Diisobutene, Butanol, Methacrylic acid, Maleic anhydride.

Learning outcomes:

* Design and evaluate a process for the manufacture of C_3 fractions.

* Design and evaluate a process for the manufacture of C_4 compounds.

Petrochemicals from Aromatic compounds: Production and separation of aromatics, Aniline, Phenol, Maleic anhydride, Toluene diisocynate, Phthalic anhydride, Dimethyl terephthalate.

Learning outcomes:

Design a process for the production of aromatics.

Develop a process for the separation of aromatics.

Design of petrochemical equipment: Pyrolysis furnace, pyrolysis reactor, super fractionator, fixed bed reactor, multiphase reactor.

Learning outcomes:

Design of pyrolysis furnace, pyrolysis reactor and super fractinator.

Design of fixed bed reactor, multiphase reactor.

Text Books :

1. Ethylene & its derivations - S.A. Miller
2. Propylene and its derivations - E.G. Hancock.
3. Benzene, Toluene, Xylene and their Derivations. E.G. Hancock.
4. Petrochemicals by B.K.Bhaskara Rao.

CHEM-1.2.4 B – ELECTIVE-III (Process dynamics and control-II)

Objectives :

The main purpose of teaching Process Dynamics and Control as elective-II for M. tech second year postgraduate students is to make them to understand the unity in outlook that has been lacking in the field of chemical reactor design. The stability viewpoint does in a sense in diverse areas like stirred tank reactor, plug flow reactor. The course in common emerge as qualitative description of the behavior of the respective models, for the stability viewpoint deals with certain structural aspects present in both problems.

Outcome:

* The student should be able to know a brief introduction about the most common chemical reactor models. The subject of steady state multiplicity in stirred tank reactors and develops uniqueness criteria for various cases that may be of interest for design.

* The student should be able to know the interpretation of terms such as steady and stable. The student should have knowledge to explore the implications of the stability concept in dealing with finite disturbances of practical magnitude.

* The student should be in a position to analyze from ordinary differential equation models to partial differential equation models.

* The student should be in a position to understand the steady state multiplicity, local stability, and regional stability are treated for distributed systems.

SYLLABUS

Unit I : Mathematical modeling of reactors - Mass and energy balance equations for CSTR,PFTR, TRAM, TRRM, catalyst particle - multiphase models. Lumped parameter model - steady state multiplicity of a CSTR- Van Herden diagram - criteria for uniqueness of steady state for isothermal and temperature dependent reactors and multiphase systems - design consideration.

Learning outcomes

* The student should be able to know a brief introduction about the most common chemical reactor models and Mathematical modeling of reactors

* The student should have knowledge to explore the subject Lumped parameter model design.

Unit II : Geometry of dynamics for a lumped parameter model - stable and unstable steady states - phase plane for the CSTR and eigen values - linear second order system and eigen vector - Liapunov stability criterion and Liapunov functions - fundamental linearization theorem - local stability and steady state operating curves for a temperature - dependent reactor.

Learning outcomes

* Able to solve the problems related to Geometry of dynamics for a lumped parameter model Able to calculate the open loop response of a sampled data system and stability

* The student should be in a position to analyze from Liapunov stability criterion and Liapunov functions

Unit III : Region of asymptotic stability and v-function in x-space - Krasovskil's theorem and V-function in f-space.

Learning outcomes

* Able to solve the problems related to Region of asymptotic stability and v-function in x-space and Student can develop a

* Able to solve the Design Krasovskil's theorem and V-function in f-space.The student should be in a position to understand the steady state multiplicity

Unit IV : Steady states in distributed parameter systems - uncoupling the energy and mass balances for TRAM model - Steady state models of a PFTR and parametric sensitivity - Steady state multiplicity of a TRAM and catalyst particle model - uniqueness criteria for fixed bed reactors.

Learning outcomes

* Able to solve the problems related to Steady states in distributed parameter systems -Able to solve the problems related to examples of non linear systems and also develops Methods of phase plane analysis.

* The student should be in a position to understandSteady state models of a PFTR and parametric sensitivity - Steady state multiplicity of a TRAM

Unit V : Local stability of distributed parameter systems - the techniques of linearization of nonlinear differential equations and uncoupling of certain transient conservation equations - applications of these techniques to the cases of catalyst particle and TRAM.

Methods of solution of transient mass and energy balance quations applied to catalyst particle model and TRAM - Galerkin method - Collocation method.

Learning outcomes

* Able to solve the problems related to Local stability of distributed parameter systems - the techniques of linearization of nonlinear differential equations and uncoupling of certain transient conservation equations - applications of these techniques to the cases of catalyst particle and TRAM.

* Able to solve the problems related to Methods of solution of transient mass and energy balance equations applied to catalyst particle.

Text Book:

Stability of Chemical Reactors by Daniel D. Perlmutter, John Weily and Sons Inc. (New York, (1976).

CHEM-1.2.4 C- ELECTIVE-III (Electro Chemical Engineering-II)

Objectives: The main objectives are to provide

1. Knowledge on Electroplating, Electroforming, electro refining, electro wining.
2. Knowledge on Electrolysis and Manufacturing process.
3. Knowledge on primary & secondary batteries and fuel

Outcome: At the end of the course, the student will be able to

1. Explain different electrochemical ore beneficiation techniques, electroplating, electro refining and electro winning.
2. Take part in commercial and industrial manufacturing units using electrolysis.
3. Design, test and evaluate batteries e.g. Primary and secondary batteries, charge/discharge cycles, overpotential, battery capacity, state of charge, state of health, impedance.
4. Construct, Compare and test Fuel cells.

SYLLABUS

Part –A

Electroplating, Electroforming and Electrophoresis

Electrorefining of metals - Copper, Silver, Gold, Nickel, Lead and Cobalt.

Electrowinning of metals - Copper, Zinc, Cadmium, Chromium and Manganese.

LO1: Appraise various metal extraction procedure by electrochemical means

LO2: Recommend the process conditions Electrolysis of Alkali Halides and Sulfates - Chlorine and Caustic, Potassium halides, Hydrochloric acid, Fluorine and sodium sulfate. Manufacture of Hydrogen and Oxygen. Electrolytic Reduction and Oxidation - Persalts, Cuprous oxide, Mercuric oxide, Manganese dioxide and Perchlorates. Electrolysis of fused Salts - Aluminum, Magnesium, Sodium, Beryllium and Zirconium.

LO3: Choose appropriate manufacturing processes of ionic salts by electrochemical schemes

LO4: Compare different sets of conditions for the manufacture of a given salts

Part –B

Batteries: Classification of cells and batteries, theoretical cell voltage, capacity, energy, electrochemical principles and reactions

Primary batteries: Zinc carbon batteries (Leclanche and Zinc chloride cell system), Magnesium and Aluminum batteries, Alkaline manganese dioxide batteries, Lithium batteries.

Secondary batteries: Lead acid batteries, nickel cadmium batteries, nickel metal hydride batteries, lithium ion batteries, rechargeable zinc, alkaline, manganese dioxide batteries

LO5: Evaluate the working behavior of different batteries

LO6: Estimate the charge discharge characteristics of a battery

Fuel cells: Molten carbonate fuel cell(MCFC), phosphoric acid fuel cell(PAFC), Solid oxide fuel cell (SOFC), proton exchange membrane fuel cell(PEMFC).

LO7: Assess the working of different Fuel cells

LO8: Construct and test of Fuel Cell

Textbooks:

1. Electrochemical Engineering by Mantell, C.L. McGraw–Hill

2. Electrochemistry Principles and Applications Edmund Potter, Cleaver–Hume Press Ltd.

3. Handbook of batteries by David linden and Thomas B Reddy, McGraw –Hill

CHEM-1.2.5- ELECTIVE-IV

CHEM-1.2.5 A-ELECTIVE-IV (Corrosion Engineering-II)

Common for M.Tech (Chemical, MPE, IPCE, CACE & Biotechnology)

Objectives:

* To enable the principles of corrosion, common corrosion forms, uniform, galvanic, pitting, inter granular, crevice, dezincification, stress corrosion, corrosion fatigue, hydrogen embrittlement corrosion control methods, and material selection to reduce corrosion cost.

* To enable the ability to understand electrochemical fundamentals

* To enable the ability to understand corrosion preventing methods

Outcome:

* The student would know application of weight loss method

* The student would know application of cathodic protection, anodic ptotection

* At the end of this course, the student would know effective surface preparation of specimen can be done

* After completion of this course, the student would understand the causes and the mechanisms of various types of corrosion, including uniform corrosion, galvanic corrosion, crevice corrosion, pitting corrosion, intergranular corrosion.

* The student would know application of Corrosion Processes and Evans Diagrams and application of electroplating, coatings and importance of inhibitors.

SYLLABUS

Corrosion in selective environments: Marine, Acids (Sulfuric acid, Hydrochloric acid, Nitirc acid, Phosphoric acid) Biological and industrial gases ($SO_2$$H_2S$).

* Able to understand corrosion and its mechanism in marine atmosphere.

* Able to understand corrosion in acidic media like Sulfuric acid, Hydrochloric, etc. Corrosion Testing - Purposes, Materials and specimen. Surface preparation, Measuring and weighing , Exposure Techniques - duration, Planned - Interval Tests, Aeration, cleaning specimens after exposure, Temperature, Standard expression for corrosion rates - Galvanic Corrosion, Erosion Corrosion, crevice Corrosion, Intergranular corrosion, test for stainless steels, warren test pitting, stress corrosion, Paint tests, Sea Water tests, Presenting and summarizing data - Nomo graph for corrosion rates and interpretation of results.

* Able to understand the importance of surface preparation.

* Able to understand the application of Standard expression for corrosion rates using weight loss method.

* Able to understand the application of different corrosion tests.

Cathodic and anodic protection, surface preparation for coatings and chemical conversions: Degreasing, Descaling , Polishing - Anodized coating : anodizing oxidizing, chromate coating, phosphate coatings - Metallic coatings : Hot dipping, cementation, vapor deposition of metallic coating; Sprayed coatings: flame spraying plasma spraying, Galvanizing - Electroplating : Nickel & chromium coatings, chromizing.- Organic coatings : paints, enamels, lacquers, resin mixtures.

* Able to understand the application of Cathodic and anodic protection.

* Able to understand the uses of Degreasing, Descaling , Polishing.

* Able to understand the importance of Hot dipping, cementation, vapor deposition of metallic coating. Linings, laminates, reinforced plastic, fibre glass - Corrosion inhibitors: mechanism of inhibition, recirculating of water of water systems.

* Able to understand the importance of Corrosion inhibitors and mechanism of inhibition. Measurement and testing of preventive coatings; Thickness and Resistance tests for anodized, Painted, electroplated surfaces using polarization resistance, Linear polarization, curve fit analysis and Electrochemical impedance spectroscopy.

* Able to understand the Thickness and Resistance tests.

* Able to understand the linear polarization and curve fit analysis.

Reference books :

1. Mars G.Fontana - Corrosion Engineering

2. Burns, R.M., Bradley, W.W., 'protective coatings for Metals.' Chapters 2 to 18.

Reference Books :

Corrrosion Volumes 1 & 2 by L.L. Shrier, Newnes - Butter-worths, London.

CHEM- 1.2.5 B - Elective-IV (Energy Engineering-II)

Common for M.Tech (Chemical, MPE, IPCE, CACE & Biotechnology)

Course objectives:

1. The student is provided with the fundamentals of renewable energy processes.

2. Basic information to comprehend the various non-conventional energy systems would be illustrated to the student.

3. Various ways of obtaining energy from ocean can be demonstrated to the student.

4. The methods of energy conservation and the opportunities for conservation would be emphasized.

5. Economics involved in the energy production processes would be enumerated to the student.

Course Outcomes:

1. Methods to be adopted to utilize biomass as an important energy source

2. Application of thermodynamics to obtain energy from various sources

3. Possible mechanism to draw energy from wind and other natural resources

4. Knowledge about energy conservation and storage

5. Emerging technologies to produce energy such as thermionics, thermoelectricity etc.

SYLLABUS

Fundamentals of energy science and technology: Introduction – Energy, economy and social development – Oil crisis of 1973 – classification of energy sources – consumption trend of primary energy resources – importance of non-conventional energy sources – energy chain – common forms of energy – advantages and disadvantages of conventional energy sources – salient features of non-conventional energy sources – energy densities of various fuels – environmental aspects of energy – The United Nations Framework Convention on Climate Change – Energy-environment-economy – World energy status – energy scenario in India. Energy conservation and efficiency: Introduction – important terms and definitions – important aspects of energy conservation – global efforts, achievements and future planning – energy conservation/efficiency scenario in India – energy audit – energy conservation opportunities – cogeneration – combined cycle plants. Energy storage: Introduction – necessity of energy storage – specifications of energy storage devices – energy storage methods.

Learning outcomes:

1. The student can identify the ways and means of conservation of energy once the student completes learning this unit.

2. The student can appraise the necessity of energy storage and recommend the methods for energy storage at the end of the unit.

Wind energy: Introduction – origin of winds – nature of winds – wind turbine siting – major applications of wind power – basics of fluid mechanics – wind turbine aerodynamics – wind turbine types and their construction – wind energy conversion systems – wind-diesel hybrid system – effects of wind speed and grid condition – wind energy storage – environmental aspects – wind energy program in India.

Learning outcomes:

1. By studying this unit, the students will be able to predict where the wind power plants can be located.

2. At the end of this unit, the students can recommend appropriate technology for obtaining geothermal energy in a given situation.

Biomass: Introduction – Photosynthesis process – usable forms of biomass, their composition and fuel properties – biomass resources – biomass conversion technologies – urban waste to energy conversion – biomass gasification – biomass liquefaction – biomass to ethanol production – biogas production from waste biomass – energy farming. Geothermal energy: Introduction – applications – origin and distribution of geothermal energy – types of geothermal resources – analysis of geothermal resources – exploration and development of geothermal resources – environmental considerations – geothermal energy in India.

Learning outcomes:

1. After completing this unit, the students will be able to choose appropriate biogas plant for a given location and able to provide dimensions of the same.

2. At the end of this unit, the students will be able to recommend a process for utilizing the biomass for a given application.

Ocean Energy: Introduction: Tidal energy – wave energy – ocean thermal energy. Small hydro resources: Introduction – advantages and disadvantages of small hydro schemes – layout of a micro-hydroscheme - water turbines – turbine classification, characteristics and selection – generators – present status.

Learning outcomes:

1. At the end of this unit, the students can recommend appropriate technology for obtaining energy from ocean in a given situation.

2. Suitable scheme for generating electricity from small hydroresources can be suggested by the student after the completion of this unit.

Emerging technologies: Introduction – fuel cell – hydrogen as energy carrier. Miscellaneous non-conventional energy technologies: Introduction – magneto hydrodynamic power conversion – thermoelectric power generation – thermionic power conversion. Financial and economic evaluation: Introduction – basic terms and definitions – calculations for the case of single payment – calculation for uniform series of payments – calculations for uniform gradient series of payments – calculations for geometric gradient series of payments – effect of inflation on cash flows – comparative economic evaluation of alternatives – effect of depreciation and tax on cash flow.

Learning outcomes:

1. New technologies for obtaining energy from various renewable sources can be evaluated by the student.

2. Economic factor in the energy production by various technologies can be compared by the student at the end of this unit.

Text book:

Non-Conventional Energy Resources by B.H. Khan, 3/e, McGraw Hill (2017).

Reference book:

Fundamentals of Renewable Energy Processes by Aldo V. Da Rosa. Elsevier (2005).

CHEM- 1.2.5 C - Elective-IV (Reaction Engineering-II)

Common for M.Tech (Chemical, MPE, IPCE, CACE & Biotechnology)

SYLLABUS

UNIT - I : Laboratory Reactors - Interpretation of Experimental Data - Interpretation of Laboratory Kinetics Data - Homogeneous and Heterogeneous Laboratory Reactors. Calculation of Global Rate - The structure of Reactor Design. (Scope: Chapter 12 of J.M Smith 3rd Edition)

UNIT - II : Design of Heterogeneous Catalytic Reactors Isothermal and Adiabatic Fixed Bed Reactors Non-isothermal, Non-adiabatic Fixed Bed Reactors. (Scope: Chapters 13.1 - 13.9 of J.M Smith 3rd Edition)

UNIT - III : Design of fluidized bed Reactors - Two -Phase Fluidized Bed model - Operating characteristics - Slurry Reactors - Trickle - Bed Reactors - Optimization. (Scope: Chapter 13.10 - 13.13 of J.M Smith 3rd Edition.)

UNIT - IV : Fluid - Solid Noncatalytic Reactions - Design concepts - Single Particle Behavior - Reactor Models. *(Scope: Chapter 14 of J.M Smith 3rd Edition)*

UNIT - V : Short notes from the portions of all the above four units. Four bits are to be answered out of 7 bits (Not more than 2 bits to be given from any one Unit).

Text Book:

Chemical Engineering Kinetics by J.M Smith, McGraw - Hill Book Company, 1980, 3rd Edition.

CHEM 1.2.6: AUDIT COURSE -2

CHEM 1.2.6 A : DISASTER MANAGEMENT (Audit Course -2)

Common for M.Tech (Chemical, MPE, CACE, IPCE, Biotechnology)

Introduction to Disaster: Definition, Factors And Significance; Difference Between Hazard And Disaster; Natural And Manmade Disasters: Difference, Nature, Types and Magnitude.

Repercussions Of Disasters And Hazards: Economic Damage, Loss of Human And Animal Life, Destruction Of Ecosystem. Natural Disasters: Earthquakes, Volcanisms, Cyclones, Tsunamis, Floods, Droughts And Famines, Landslides And Avalanches, Man-made disaster: Nuclear Reactor Meltdown, Industrial Accidents, Oil Slicks And Spills, Outbreaks Of Disease And Epidemics, War And Conflicts.

Disaster Prone Areas in India Study Of Seismic Zones; Areas Prone To Floods And Droughts, Landslides And Avalanches; Areas Prone To Cyclonic And Coastal Hazards With Special Reference To Tsunami; Post-Disaster Diseases And Epidemics

Disaster Preparedness And Management Preparedness: Monitoring Of Phenomena Triggering A Disaster Or Hazard; Evaluation Of Risk: Application Of Remote Sensing, Data From Meteorological and Other Agencies, Media Reports: Governmental And Community Preparedness.

Risk Assessment Disaster Risk: Concept and Elements, Disaster Risk Reduction, Global and National Disaster Risk Situation. Techniques of Risk Assessment, Global Co-Operation In Risk Assessment and Warning, People's Participation In Risk Assessment. Strategies for Survival

Disaster Mitigation Meaning, Concept and Strategies Of Disaster Mitigation, Emerging Trends In Mitigation. Structural Mitigation And Non-Structural Mitigation, Programs Of Disaster Mitigation In India.

REFERENCES:

1. R. Nishith, Singh AK, "Disaster Management in India: Perspectives, issues and strategies "'New Royal book Company.

2. Sahni, PardeepEt.Al. (Eds.)," Disaster Mitigation Experiences and Reflections", Prentice Hall Of India, New Delhi.

3. Goel S. L., Disaster Administration And Management Text And Case Studies",Deep & Deep Publication Pvt. Ltd., New Delhi.

CHEM 1.2.6 B: ENTREPRENEURSHIP (Audit Course -2)

Common for M.Tech (Chemical, MPE, CACE, IPCE, Biotechnology)

Unit -I : Basic Concepts of Management:Management :- Definition, Nature and Importance ; Functions of the Management; Levels of Management; F.W Taylor's Scientific Management; Henry Fayol's Principles of Management.

Unit-II : Forms of Business Organizations: Introduction, Types of Business organizations: Private Sector- Individual Ownership , Partnership, Joint stock companies and Co-Operative organizations; Public sector- Departmental Organizations, Public Corporations and Government Companies; The Joint sector Management.

Unit-III Production and operations Management: Plant location- Factors to be considered in the selection of Plant location; Break - even analysis-Significance and managerial applications; Importance of Production Planning and Control and its Functions; Human Resource Management and Functions of Human Resource Manager (in brief); Functions of Marketing; Methods of Raising Finance.

Unit-IV : Entrepreneurship: Definition, Characteristics and Skills, Types of Entrepreneurs, Entrepreneur vs. Professional Managers, Growth of Entrepreneurs, Nature and Importance of Entrepreneurs, Women Entrepreneurs, Problems of Entrepreneurship.

Unit-V : Entrepreneurial Development and Project Management: Institutions in aid of Entrepreneurship Development, Idea generation: Sources and Techniques; Stages in Project formulation; Steps for starting a small enterprise - Incentives for Small Scale Industries by Government.

Text Books:

1. Sharma, S.C, and Banga, T.R., Industrial Organization & Engineering Economics, Khanna Publishers, Delhi, 2000.

2. Vasant Desai, The Dynamics of Entrepreneurial Development and Management (Planning for future Sustainable growth), HImalayan Publishing House, 2018.

Reference Books:

1. Aryasri, A.R., Management Science, McGraw HIll Education (India Private Limited, New Delhi 2014.

2. Sheela, P. and Jagadeswara Rao, K., Entrepreneurship, Shree Publishing House, Guntur,

III SEMESTER

CHEM-2.1.1: Elective –V

CHEM-2.1.1 A : Elective-V (Process Modeling and Simulation)

Common for M.Tech (Chemical, MPE, CACE & IPCE)

Objective:

Deals with writing various process models based on basic physical process. It also deals with solving the various models by means of numerical methods by computer simulation. By studying this course, one can simulate various chemical processes by computer simulation.

Outcome:

Understand the writing of a model of a process based on basic physical processes like mass, momentum and energy balances.

1. Able to develop a model equation for Tanks, Isothermal and Non-Isothermal Systems
2. Able to understand the models for binary distillation column, batch reactors, etc.
3. Able to solve the model equations by numerical methods.

Syllabus

Principles of formulation - Continuity equations – Energy equation – Equation of motion – Equations of state – Transport equations – Chemical Kinetics – Algebraic and Integral / differential equations, Explicit and Implicit equations –Numerical Integration,Feed forward and feed backward control. Basic modeling for tank system, mixing vessel – Simultaneous mass and energy balances – Models for boiling, batch distillation, and partial condenser. Models for Reactor – Model for heterogeneous catalysis – Models for pumping system – Model for heat exchanger.

Operational blocks in simulation- Simulation Programming – Simulation examples of three CSTR's in series, gravity flow tank, binary distillation column, non–isothermal CSTR.

Implicit function convergence, Internal–halving convergence, Newton–Raphson method, False position convergence, Explicit convergence methods, Numerical Integration, Euler Integration, Runge - Kutta (fourth order) method.

Textbooks:

1. Process Modeling, Simulation and Control for Chemical Engineers by Luyben, W.L., McGraw Hill Books Co.
2. Mathematical Modeling in Chemical Engineering by Roger, G.E. Franks – John Wiley Sons Inc.

Reference Book:

Mathematical Methods in Chemical Engineering by V.G. Jenson and G.V. Jefferys, Academic Press – 2nd Edition.

CHEM-2.1.1 B : Elective-V (COMPUTATIONAL METHODS)

Objective:

The main purpose of teaching "COMPUTATIONAL METHODS" for the first year M.TECH students is to introduce the basics of computational techniques subject for CACE specialization students to gain fair knowledge of overall computational techniques. To learn various computational methods which are available to solve the chemical engineering problems which are related to computer aided chemical engineering applications.

Out come:

Student gains fair knowledge which every CACE specialization student should know to solve the problems. Student will learn the importance of solving the problems. Student is able to gain the complete knowledge on the subject. This knowledge is very helpful for the student to solve the different types of problems in Chemical Industry with different computational methods.

Syllabus

1. Linear and Non-linear Algebric Systems: Elimination methods for solving linear systems, matrix inversions, factorization, norm and rank; Solutions of nonlinear algebric equations, iterative methods, methods of Newton, Secant, Bracketing and Bisection, Newton's methods for multiple non-linear equations, Jacobian, Quasi-Newton methods.

2. Matrix Eigen Value Analysis: Orthogonal matrices, eigen values and vectors of real matrix, eigen values and properties of linear systems, estimating eigen values, eigen vector matrix decomposition and basis sets, numerical calculation eigen values and vectors, extremal eigen values, QR method, Single Values Decomposition, eigen problems in quantum mechanics, computing the roots of polynomial.

3. Initial Value Problems: Initial Value Problems of ordinary differential equations, polynomial interpolation, Newton Cotes integration, Gaussian quadrature, multi- dimensional integrals, dynamic stability, accuracy and stability of single step methods, stiff stability of BDF methods, simplistic methods for classical mechanics, differential-algebraic equation systems, parametric continuation.

4. Boundary Value Problems (BVPs) : BVPs from conservation principles, real space versus function space methods, finite difference methods for 2-D BVP, extension of finite difference method, chemical reaction and diffusion in spherical catalysts pillet, conversion/diffusion equation, modeling a tubular reactor with dispersion, numerical issues for discretized PDEs with more than tow spatial dimensions, finite differences in complex geometries, finite volume method, finite element method (FVM).

Text book:

K.J.Beers, Numerical Methods for Chemical Engineering, Cambridge University Press, 2006.

Reference books:

1. B.A. Finlayson, Introduction to Chemical Engineering Computing, John Wiley, 2006
2. A.Constantinides and N.Mostoufi, Numerical Methods for Chemical Engineers with MATLAB Applications, Prentice Hall, 1999.
3. A.Varma and M.Morbidelli, Mathematical Methods in Chemical Engineering, Oxford University Press 1997

4. M.B.Cutlip and M.Shachasm, Problem Solving in Chemical Engineering with Numerical Methods, Prentice Hall, 1999

5. OT.Haanna and IO.C.Sandall, Computational Methods in Chemical Engineering, Prentice Hall, 1995

6. J.H.Mathews and K.D.Fink, Numerical Methods using MATLAB, 4th ed.,Prentice-Hall India Private Limited, 2005

CHEM-2.1.1 C : Elective-V
(Advanced Engineering Mathematics & Statistics)
Common for M.Tech (Chemical & CACE)

Objective:

The main objective is to make the students get familiar with the Advanced Numerical Methods and Statistical techniques by learning them. The student should be able to learn how to get the Numerical solutions of Boundary value problems as these arise in several engineering studies, such as in Hydrodynamics, Quantum mechanics, applied elasticity, Heat and Mass transfer etc. The student should be able to study about Probability and Statistics; which provides a mathematical frame work for different assertions and is essential in every decision-making process.

Outcome:

The Students come out with the good knowledge of Advanced Numerical Methods and Statistical Techniques and they will be able to implement these techniques whenever required in their further studies.

SYLLABUS

1. Finite Difference Methods of Solving Boundary value problems Associated with partial Differential Equations: Introduction, Finite difference scheme for Laplace's equation, Finite difference methods for the parabolic type of partial differential equations, Forward difference method, Crank-Nicholson implicit method, Stability analysis, backward difference equation for parabolic equations, finite difference explicit scheme for the wave equation. An implicit scheme for the linear wave equation, method of characteristics for solving hyperbolic partial differential equations.

2. Boundary value problems in ordinary differential equations: Reduction to an intial value problems, Finite difference method, The shooting method, Multiple integration.

3. Statistics and probability: Concept of random variable – distribution and density functions conditional distribution and density functions, Functions of one and two random variables, Many random variables, Concept of Stochastic Processes.

Textbooks:

1. Computer Programming and Numerical Analysis by N.Datta Published by Universities Press(India) Private Limited, 3-5-819, Hyderabad – 500029 for Section I & II.

2. Probability by Seymour Lipschutz: Schaum's outline series for Section III.

3. Introductory Methods of Numerical Analysis by S.S.Sastry.

CHEM-2.1.2: Elective –VI (Open Elective)
CHEM-2.1.2 A : Elective-VI (Nanotechnology)
Common for M.Tech (Chemical, MPE, CACE, IPCE, Biotechnology)

Objectives:

Nanotechnology may be treated as Green technology. It is one of the most advanced technologies now-a-days. It leads to have revolutionary changes in the fields of medical, Bio-medical, and fabrication of materials. Technologists are able to prepare ageless materials with the help of nano-techniques. Main objectives of the subject nanotechnology are :

1. To define green technology properly
2. To expose the students with new techniques of the nanotechnology.
3. To make them to learn the importance of quantum technology
4. To learn the procedure ageless materials to avoid wear-tear.
5. To learn the importance of nano –robots, machines
6. To know about the latest microscopes such as SEM, TEM
7. To know the importance of nanotechnology in the dawn of optical instruments

Outcome:

1. Application of nanotechnology in the development of energy
2. Application of nanotechnology in the development of solar panels, Fuel cells
3. Knew the importance of atoms manipulation
4. Knew that the applications of nanoparticles in the development of DVD, LEDs etc.
5. Biomedical applications in terms of preparing artificial, drug delivery, encapsulation, addition to that pharmaceuticals.

SYLLABUS

1. Introduction to nanotechnology, molecular and atomic size, surface and dimensional spaces. Molecular nanotechnology: atoms by inference, electron microscopes, nanomanipulator, nanotweezers, atom manipulation, nanodots, nanolithography.

Learning Outcomes:

* Define the term nanotechnology to understand in a better way the subject basics

* Demonstrate the different types of Electron Microscopes and their uses.

2. Nanopowders and nanomaterials: preparation, plasma arcing, chemical vapor deposition, sol-gels, electrodeposition, Ball milling, applications. Carbon nanotubes: types, formation, assemblies, purification, properties and uses.

Learning Outcomes:

* Summarize the nanomaterials used for the preparation of nanopowders

* Apply and selection of the different methods to prepare nanopowders

* Classify the carbon nanotubes and purification process.

3. Molecular mimics: Catenanes and rotaxanes, various molecular switches, synthesis of rotaxanes and catenanes, molecular computers, chemical rotors, prodders, flippers, atom shuttles, actuators, contacts.

Learning Outcomes:

* Categorize the molecular switches and synthesis of rotaxane and catenanes

* Examine the function of molecular computers

4. Nanobiometrics: Lipids as nano-bricks and mortar, self – assembled monolayers, proteins, 3-D structures arising from amines acids, nanoscale motors, Biological Computing, ion channels as sensors, Information in DNA structure, using DNA to build nano-cubes, hinges, smart glue, wire template.

Learning Outcomes:

* Evaluate the importance of nanobiometrics as self-assembled monolayers and nanoscale motors.

* Explain the process of biological computing and using DNA as hinges, smart glue, wire template

5. Optics, photomics and solar energy: Properties of light and nanotechnology, Interaction of light and nanotechnology, Nanoholes and photons, Imaging, New low cost energy efficient windows and solar absorbers based on nanoparticles, Photonic crystals, surface wave guides and control of light paths.

Learning Outcomes:

* Discuss about the optics, photomics and solar energy with reference to light properties.

* Chose a technique using nanoparticles to manufacture solar absorber, photonic crystals and change the light path.

6. Nanoelectrons: birth of electrons, semiconductors, transistor, integrated circuits, the tools of micro and nanofabrication, quantum electronic devices, quantum information and quantum computers, experimental implementations of quantum computers.

Learning Outcomes:

* Appraise different phased in the development of nanoelectornics tools.

* Construction of quantum computers and its experimental implementations.

7. Future applications: microelectomechanical systems, nano-robots , ageless materials, invisible mending of atomic dislocations inside damaged materials, nanomechanics and nanoelasticity, nanoparticle coatings, nanoelectronic and magnetic devices and new computing systems, optoelectronic devices, environmental applications.

Learning Outcomes:

* Assess the future application of nanotechnology in various fields

* Create new tools with nanotechnology to prepare new devices

Text-book:

1. M.Wilson, K.Kannangara, G. Smith, M. Simmons and B. Ragues, Nanotechnology, Overseas press (India) Private Ltd; New Delhi, 2005.

Reference books:

1. G. Ali Mansoori*, Principles of Nanotechnology, World Scientific Publishing Company, 2005.

2. G. Timp, Nanotechnology, Springer-Verlag, Network, 1999.

3. P. Poole and F.J. Owens, Introduction to Nanotechnology, John Wiley, 2003.

4. D.Ratner and M.Ratner, Nanotechnology: A Gentle Introduction, Pearson Education,2003.

5. B. Bhusan, Handbook of Nanotechnology, Springer, 2004

CHEM-2.1.2 B: Elective-VI (POLLUTION CONTROL)

Common for M.Tech (Chemical, MPE, CACE, IPCE, Biotechnology)

Objectives:

* Focus on classification of air pollutants, water pollutants and solid waste –causes, effects and control methods, need of environmental Legislation.

Outcome:

* Enables the students to adopt the preventive measures for the control of air pollutants, waste water treatment methods, and solid waste management methods in domestic, municipal waste.

* Enables the students to understand the control measures of pollutants emitted from different industries like Paper and pulp, fertilizer, sugar and alcohol, petrochemical and petroleum refinery, pharmaceutical and metal finishing industries.

SYLLABUS

Kinds of ecology, environment and ecofactors, types of ecosystems, sulphur cycles, phosphorous cycle, Nitrogen cycle and hydrological cycle Sources for water, Air and solid pollution, Analysis and effects of the pollutants in air, in water, Solids(particulate matter, SOx, NOx, Cox, CHx).

Limits of pollutants, Environmental Legislation. Control aspects of various pollutants Air (Particulate matter, SOx, NOx, COx, CHx, Noise) water (primary, secondary and territory treatment techniques) Solids (recycling, incineration,bio-conversion).

Case studies of Industries: Paper and pulp, petrochemical, Fertilizer, Pharmaceuticals, tannery, sugar and alcohol industries, metal finishing industries.

Learning Outcomes:

* Describe different ecosystems

* Explains the bio-geochemical cycles

* classify the main types of pollution and their effects

* Describe the sources of pollution and their characteristics

* Describe the effects of air and water pollution on the environment and on human health

* Explain the importance of Environmental Legislation for pollution prevention and control

* Evaluate the preventive measures for the control of air pollutants – SPM

* Select the most appropriate technique to control SOx, NOx, COx, CHx

* Describe the primary, secondary and territory treatment techniques waste water treatment methods

* Propose control measures of pollutants emitted from different industries like paper and pulp

* Plan to select most appropriate technique to control pollutants from petrochemical and refineries

* Explain the control aspects of pollutants from Fertilizer, Pharmaceuticals

* Elucidate the control aspects of pollutants from tannery, sugar and alcohol industries, metal finishing industries

Text books:-

1. S.P.Mahajan., Pollution control in process Industries, Tata McGraw hill publishing company.

2. Arcadio P. Sincero and Georgia Sincero., Environmental Engineering

3. Environmental Pollution Control., by C.S.Rao, wiely eastern ltd.

CHEM-2.1.2 C: Elective-VI (Corrosion Engineering)

Common for M.Tech (Chemical, MPE, CACE, IPCE, Biotechnology)

Course Objectives:

* Basic aspects of electrochemistry relevant to corrosion phenomena,

* Importance and forms of corrosion.

* Knowledge on corrosion rate expressions and measurement techniques.

* Basic knowledge on remedial measures for corrosion.

Course Outcomes:

At the end of the course, the student will be able to

* Identify various forms of corrosion.

* Determine corrosion rates for metals from their polarization curves

* Analyze corrosion rate characteristics from electrochemical impedance spectroscopy

* Select suitable corrosion resistant coatings, oxide layers for various applications

SYLLABUS

Introduction and scope: Corrosion definition, wet and dry corrosion, mechanism, electro-chemical principles and aspects of corrosion, Faradays laws, resistance, specific resistance, conductance, specific conductance, transport numbers, ionic mobility, corrosion rate expressions, calculation of corrosion rates, thermodynamic aspects of corrosion, equilibrium potential, Nernst equation for electrode potential, EMF series, over voltage, application of Nernst equation to corrosion reactions,

Polarisation and corrosion potentials: References electrodes for corrosion measurements, types of polarisation, concentration, activation and resistance polarizations, Tafel constant, Evans diagrams, anodic control, cathodic control, mixed control, Pourbaix-diagram for Fe-H_2O system, Various forms of corrosion: Uniform attack, galvanic corrosion, crevice corrosion, pitting corrosion, intergranular corrosion, selective leaching (dezincification), cavitation damage, fretting corrosion, erosion corrosion, and stress corrosion and remedial measures,

Prevention techniques: Modification of the material by alloying, appropriate heat treatment, chemical and mechanical methods of surface treatment, metallic, non-metallic linings, inhibitors, passivity, Cathodic protection and

anodic protection.

TEXT BOOKS:

1. 'Corrosion Engineering' by Mars G. Fontana, Tata McGraw Hill Publishing Company, New Delhi

2. 'Corosion and Corrosion Control' by H.H.Uhllg, John Wiley & Sons Inc., America

REFERENCE BOOKS:

1. 'Electrochemistry' by Samuel Glasstone, Litton Educational Publishing Company

2. 'Electrochemistry, Principles & Applications' by Edmond C.Potter, Cleaver Hume Press Limited

1/2 M.TECH (MINERAL PROCESS ENGINEERING)
FIRST SEMESTER

(With Effect From 2021-22 Admitted Batch Onwards)

Under Choice Based Credit System

Code No.	Course	Credits	Theory	Tutorial	Lab	Total	Sessional marks	Exam marks	Total marks
MPE 1.1.1	Chemical Reaction Engineering	3	3	1	—	4	30	70	100
MPE 1.1.2	Transport phenomena	3	3	1	—	4	30	70	100
MPE 1.1.3	Elective-I	3	4	—	—	4	30	70	100
MPE1.1.4	Elective-II	3	4	—	—	4	30	70	100
MPE1.1.5	Research Methodology&IPR	2	4	—	—	4	30	70	100
MPE1.1.6	Audit Course–1*	0	2	-	—	2	—	—	—
MPE 1.1.7	Elective lab	2	—	—	3	3	50	50**	100
MPE 1.1.8	Seminar	2	—	—	3	3	100	—	100
	TOTAL	18	20	2	6	28	300	400	700

* To be included as 'Qualified' or 'Not Qualified' in the marks list

**only internal evaluation

Elective-I:
1. Geology-I
2. Process Dynamics and control-I
3. Electrochemical Engineering-I

Elective-II:
1. Corrosion Engineering-I
2. Energy Engineering-I
3. Reaction Engineering-I

Audit Course 1 :
1. Yoga for working professionals
2. Organizational Behaviour

1/2 M.TECH (MINERAL PROCESS ENGINEERING)
SECOND SEMESTER

(With Effect From 2021-22 Admitted Batch Onwards)

Under Choice Based Credit System

Code No.	Course	Credits	Theory	Tutorial	Lab	Total	Sessional marks	Exam marks	Total marks
MPE 1.2.1	Mineral Process Engineering	3	3	1	—	4	30	70	100
MPE1.2.2	Process Dynamic and Control	3	3	1	—	4	30	70	100
MPE 1.2.3	Processing of Ores	3	3	1	—	4	30	70	100
MPE 1.2.4	Elective-III	3	4	—	—	4	30	70	100
MPE1.2.5	Elective-IV	3	4	—	—	4	30	70	100
MPE1.2.6	Audit Course–2*	0	2	-	—	2	—	—	—
MPE 1.2.7	Elective lab	2	—	—	3	3	50	50	100
MPE 1.2.8	Seminar	2	—	—	3	3	100	—	100
	TOTAL	19	19	3	6	28	300	400	700

*To be included as 'Qualified' or 'Not Qualified' in the marks list

Elective-III:
1. Analytical techniques
2. Process Dynamics and control-II
3. Electrochemical Engineering-II

Elective-IV:
1. Corrosion Engineering-II
2. Energy Engineering-II
3. Reaction Engineering-II

Audit Course 2 :
1. Disaster Management
2. Entrepreneurship

2/2 M.TECH (MINERAL PROCESS ENGINEERING)
FIRST SEMESTER

(With Effect From 2020-21 Admitted Batch Onwards)

Under Choice Based Credit System

Code No.	Course	Credits	Theory	Tutorial	Lab	Total	Sessional marks	Exam marks	Total marks
MPE 2.1.1	Elective-V	3	4	—	—	4	30	70	100
MPE2.1.2	Elective-VI(Open Elective)	3	4	—	—	4	30	70	100
MPE 2.1.3	Dissertation (preliminary)	9	—	—	—	—	100	—	100
	TOTAL	15	8	—	—	8	160	140	300

Note: The dissertation shall be evaluated through Viva-voce examination by a committee with HOD, Chairman, Board of Studies and Research guide as members. The marks shall be awarded in the ratio of 30,30 and 40 percent by the members Respectively

Elective-V: 1. Coal Preparation
2. Advanced Mineral process Engineering
3. Process modelling and Simulation

Elective-VI(Open Elective): 1. Nano Technology
2. Pollution Control
3. Corrosion Engineering

2/2 M.TECH (MINERAL PROCESS ENGINEERING)

SECOND SEMESTER

(With Effect From 2020-21 Admitted Batch Onwards)

Under Choice Based Credit System

Code No.	Course	Credits	Theory	Tutorial	Lab	Total	Sessional marks	Exam marks	Total marks
MPE 2.2.1	Dissertation	16	—	—	—	—	—	100	100
	TOTAL	16	—	—	—	—	—	100	100

Note: The dissertation shall be evaluated through Viva-voce examination by a committee with an external member nominated by University, HOD, Chairman, Board of Studies and Research guide as members. The marks shall be awarded in the ratio of 20, 20, 20 and 40 percent by the members respectively

SYLLABUS

M.TECH. I SEMESTER

MPE-1.1.1: Chemical Réaction Engineering

(Common for Chemical, MPE, CACE & IPCE)

Objectives:

* To focus on the thermal characteristics of various reactions and the design aspects of non isothermal and adiabatic reactors

* To focus on Heterogeneous data analysis and design

* To focus on CVD reactors

* To study the design aspects of heterogeneous catalytic systems

* To impart the knowledge on mass transfer with reaction in process catalysts

Outcome:

* Enables the students to understand the design aspects of non isothermal and adiabatic reactors

* Enables the students to on heterogeneous data analysis and design aspects of heterogeneous catalytic systems

* Able to derive the rate laws for CVD

* Able to develop the rate laws for heterogeneous fluid solid catalyzed reactions under rate limiting situations.

Syllabus

Review of Fundamentals Rate laws and stiochiometry, reactions with phase change (Scope: Chapter 3 of Fogler) Least squares Analysis of rate data: differential reactors: Laboratory reactors (Scope: sections 5.4 to 5.6 of Fogler) Multiple reactions (Scope: Chapter 9 of Fogler).

Isothermal reactor design (Scope: Chapter 4 of Fogler) Batch reactor, PFR, CSTR design. Pressure drop in reactors, Reversible reactions, unsteady state operation of reactors, Simultaneous reaction and separation

Catalysis and catalytic reactors (Scope: Chapter 6 of Fogler) Steps in catalytic reaction: derivation of rate laws, design for gas-solid reactions, heterogeneous data analysis and design; Chemical vapour deposition, catalyst reactivation, moving bed reactions.

Diffusion and reaction in process catalysts (Scope: Chapter 11 of Fogler).

Diffusion and reaction in spherical catalyst.

Internal effectiveness factor, falsified kinetics; estimation of diffusion and reaction limited regimes. Mass transfer and reaction in packed bed. Determination of limiting situations from reaction data, CVD reactors.

Non-isothermal reactor design (Scope: Chapter 8 of Fogler), Energy Balance, equilibrium conversion under adiabatic conditions unsteady state operation, multiple steady states.

Learning outcomes:

* Express important concepts in reaction kinetics and classify reactions according to different properties.

* Calculate the reaction rate constant and reaction activation energy using Least squares Analysis of rate data

* Explain

* Explain the criteria used to evaluate the laboratory reactors and solve problems related to multiple reactions

* develop performance equations for different types of reactors using mass balances

* Design different reactors and explains the Simultaneous reaction and separation.

* Develop the rate laws for heterogeneous fluid solid catalyzed reactions under rate limiting situations.

* Develop the expression for concentration profile and effectiveness factor for first order reaction in a spherical pore of a catalyst.

* Explain different mechanisms postulated for adsorption and surface reaction in catalytic reactions.

* Explain the mass transfer and reaction in a packed bed.

* Do design calculations for non isothermal and adiabatic reactors

* Investigate the effect of temperature on reactor design and reaction parameters.

* Calculates the multiple steady states for MFR type reactors

Textbook:

Fogler. H.S: Elements for Chemical Reaction Engineering 2nd Edition, Prentice Hall, New Delhi, 1992.

Reference:

Smith J.M: 'Chemical Engineering Kinetics' 3rd Edition, McGraw Hill, 1981.

MPE-1.1.2: Transport Phenomena
(Common for Chemical, MPE, CACE & IPCE)

Objectives:

* To be able to analyze various transport processes with understanding of solution approximation methods and their limitations.

Outcomes:

* Ability to understand the chemical and physical transport processes and their mechanism.

* Ability to do heat, mass and momentum transfer analysis.

* Ability to analyze industrial problems along with relevant approximations and boundary conditions.

* Ability to develop steady and time dependent solutions along with their limitations.

SYLLABUS

Unit 1: Momentum Transport : 1.1 The Equations of change for isothermal systems. 1.2 Velocity distributions with more than one independent variable. 1.3 Velocity distributions in turbulent flow. 1.4 Inter phase transport in isothermal systems.

At the end of the course, the student will be able to:

* Perform momentum balance for a given system at microscopic scale.

* Solve the governing equations to obtain velocity profile.

* Solve the unsteady state momentum equation to obtain velocity profiles

* Understand the momentum transport under turbulent conditions and can be able to find out the friction factor or drag coefficient for a fluid flow system

Unit 2: Energy Transport : 1.1 The Equations of change for non – isothermal systems. 1.2 Temperature distributions with more than one independent variable. 1.3 Temperature distributions in turbulent flow 1.4 Inter phase transport in non isothermal systems.

At the end of the course, the student will be able to:

* Perform energy balance for a given system at microscopic scale.

* Solve the governing equations to obtain temperature profiles at steady state and unsteady state condition.

* Understand the energy transport under turbulent flow conditions and can be able to find out the heat transfer coefficient.

Unit 3: Mass Transport : 1.1 The Equations of Change for multi component systems. 1.2 Concentration distribution with more than one independent variable. 1.3 Concentration distribution in turbulent flow.

At the end of the course, the student will be able to:

* Perform the mass balance for a given system at microscopic scale and can be able to solve the governing equation to obtain concentration profiles.

* Solve the unsteady state mass balanceequation to obtain concentration profiles

* Understand the mass transport phenomena under turbulent flow conditions.

Textbook:

"Transport phenomena" R. Byron Bird, Warren E. Stewart and E.N. Light foot, Wiley & Sons, Inc., New York.

Reference Books:

1."Fundamentals of Momentum, Heat and Mass Transfer" James R. Welty, Charles E. Wicks and Robert E. Wilson, John Wiley & Sons, Inc., New York.

2. "Boundary – Layer Theory", Dr.H.Sehlichting, McGraw – Hill Book Company, New York.

MPE-1.1.3: Elective – I
MPE- 1.1.3 A - Elective-I (Geology-I)

Objectives:

Geology is one of the core subjects not only for Engineers who are working in the mineral industry but also important for everybody to have better understanding of the surrounds. Following are the main objectives of the learning Geology:

1. To know about the history of the earth and its interior
2. To make the people learn about the materials available in and on the earth.

3. To know about the different natural process responsible for the formation of materials

4. To know about the things surrounded the earth's surface.

5. To familiar with dynamic processes causing for damage on the human -beings

6. To locate the new useful materials used as raw materials.

7. To educate the students know much about the stable places on the surface

8. To procure knowledge about the suitability of the dam constructions

Outcome:

Students are able to know about the following things:

1. Able to identify the useful materials in the form of ore minerals

2. Site selection for construction purposes dams/massive multistoried building etc

3. To know how to protect the environment to reduce the pollution

4. To have knowledge about the distribution of mineral resources

5. Come to understand about the process of nature beatification

6. Knowledge in the field lead to become a responsible citizen to protect nature

SYLLABUS

Unit I. General Geology : Introduction to Geology a) Origin of the earth b) Interior of the earth (crust, Mantle and core) c) Crustal abundance of elements d) Crustal abundance of rocks and minerals

Learning Outcomes:

* Outline the related things to the Earth

* Illustrate the origin and interior of the earth.

* Evaluate the composition of the overall earth

Unit II. Mineralogy: a) Symmetry elements of crystals. b)N o r m a l classes of six crystallographic systems. c) Physical & Chemical Properties of minerals. d) Origin of minerals (i)Endogenetic (ii) Exogenetic. e) Occurrence of minerals.

Learning Outcomes:

* Classify the crystals in to different crystallographic system Elaborate the properties of minerals for identification and classify the mineral

Unit III. Elements of petrology: a) Igneous rocks: Modes of occurrence, Texture and structures, Bowens reaction principles, Classification. b) Sedimentary Rocks : Mode of formation, Textures and structures, classification. c) Metamorphic Rocks: Agents of metamorphism, Zones of progressive metamorphism, Textures and structures.

Learning Outcomes:

* Classification of Rocks and their occurrence

* Discuss the different properties of rocks and texture and structure

Unit IV. Structural Geology: Dip and strike. Folds, faults, Joints, and Unconformities.

Learning Outcomes:

* Examine the recorded features of different rocks

* Make use of dip and strike to fix the position of the rock formations

Unit V. Stratigraphy: Introduction Geological Time scales Stratigraphic units distribution in India (Age wises)Important stratigraphic units and their economic importance. (i) The Archaean group (ii) The Cuddapah System (iii) The Vindhyan system (iv) The Gondwana Group (v) The tertiary group.

Learning Outcomes:

* Outline the importance of stratigraphy

* Explain the importance of time scale in the stratigraphy

* Classify the different rocks of Indian subcontinent into sub-groups

Text Books:

1. An introduction to crystal Chemistry by R.C. Evans.

2. A. Textbook of Mineralogy by Dana.

3. Rutley's elements of Mineralogy By H.H Read.

MPE- 1.1.3 B - Elective-I (Process Dynamics and Control-I)

Objectives:

The student is equipped with the analytical tools that are required in the actual design and analysis of distillation control systems. Further this subject provides a unified treatment of steady-state and control aspects of distillation operations.

Outcome:

1. The student know different techniques to formulate and solve binary and multicomponent distillation problems along with case studies

2. Knowing of those variables that affect the composition of the products

3. Dynamic mathematical tools used in controller tuning and process-identification techniques would be known.

4. Design and application of advanced control concepts to distillation would be thoroughly understood.

SYLLABUS

Unit 1 : Overview of steady state distillation concepts.

Unit 2 : Distillation control concept - Controlled variables in distillation - Basis for distillation control strategies - Dynamic Modelling & Simulation.

Unit 3 : Process identification - Frequency response and Controller tuning - Pairing and interaction in distillation.

Unit 4 : Feed forward control - Cascade and parallel cascade control - Dead time compensation.

Unit 5 : Inferential control and model algorithmic control.

Textbook :

Distillation Dynamic and Control - Pradeep B., Deshpande, ISA, Tata McGraw Hill Co. Ltd.

Reference:

Design of Distillation Column Control Systems -Luyben and Shunta ISA. Tata McGraw Hill Co.

Learning Outcomes

UNIT-I : 1. After completing this unit, the students will be able to choose a key component for the calculations involved in the multicomponent distillation operation. 2. At the end of this unit, the students can predict vapor-liquid equilibrium data by using a suitable excess Gibbs free energy equation.

UNIT-II : 1. The students will be able to identify the variables that would be useful for controlling the distillation columns. 2. For effective control of distillation columns best control strategy would be selected among various alternatives.

UNIT-III : 1. By studying this unit, the students will be able to predict the transfer function from response of different forcing functions. 2. Controller tuning parameters can be predicted for any given control system after completion of this unit.

UNIT-IV : 1. Selection of suitable advanced control action would be possible for a given situation once the student completes learning this unit. 2. The students become familiar in compensating the dead time that exists in the distillation columns.

UNIT-V : 1. The student can estimate the response of a distillation column by applying internal model control. 2. Application of appropriate mathematical models can be examined for superior control of distillation columns.

Textbook :

Distillation Dynamic and Control - Pradeep B., Deshpande, ISA, Tata McGraw Hill Co. Ltd.

Reference:

Design of Distillation Column Control Systems -Luyben and Shunta ISA. Tata McGraw Hill Co.

MPE- 1.1.3 C - Elective-I (Electrochemical Engineering-I)

OBJECTIVES:

* To enable the basic principles of electrochemistry, electrochemical devices, electro active materials used in such devices, and case studies of batteries.

* To enable the clean energy needs and demands especially in the electrochemical power generation sector; and to become educators, practicing engineers, and national leaders in electrochemical energy conversion and storage.

* To enable the integrated skills in fundamentals of electrochemistry (e.g.; chemistry, physics, mathematics, thermodynamics, and chemical kinetics) and electrochemical engineering applications (batteries, solar, flow and fuel cells, electrochemical synthesis and corrosion) to ensure successful career opportunities and growth within electrochemical power generation industries and academia.

* To enable the students in energy related programs such as clean power generation and future green technologies.

OUTCOMES:

* The student would know how to solve the problems relating to the production, storage, distribution and utilization of electrochemical energy and the associated environmental issues. And he would know integration of electrochemical principles and materials science for application in modern electrochemical devices.

* The student would know design and conduct experiments, acquire data, analyze, interpret data, solve practical and complex problems on a variety of electrochemical devices such as batteries, solar cells, flow and fuel cells and integrate the professional, ethical, social and environmental factors in electrochemical engineering and understand the impact of these factors on global energy issues.

SYLLABUS

Introduction:

Unit I : Basic Concept: Mechanism of Electrolysis, Laws of Electrolysis, Curent and Voltage Efficiency - Electrolytic dissociation, Coulometers, Ionic conduction. Electrolytic conductivity, Absolute ionic velocities, ionic mobilities, Transference Nos. Modern Ionic Theory, Ionic activity Degree of dissociation. Ionic Atmosphere Time of relaxation and relaxation effect, Electrophoretic effect - Debye - Huckel Onsager equation of conductance (Derivation is not required) and its validity.

* Able to understand the concept and applications of Laws of Electrolysis.

* Able to understand the importance and construction of Coulometers.

* Able to understand about Transference Nos.

* Able to understand Degree of dissociation.

Unit II: Thermodynamics I: Chemical Potential and Free Energy changes. Cell and Electrode potentials. Thermodynamics of Electrode potentials - Nernst Equation. Equilibrium Constant, Arbitrary Zero of potential, EMF series and their limitations Activity Coefficient of and their evaluation, Liquid Junction potentials, Concentration Cells - Reference Electrodes.

* Able to understand the concept of Chemical Potential and Free Energy changes.

* Able to understand how to calculate cell electrode potential.

* Able to understand the application of Nernst Equation.

* Able to understand how to measure Junction potential.

Unit III : Thermodynamics II : Electrode Kinetics, Role of Interface, Electric Double Layer and its capacitance - Irreversible Electrode processes - Irreversibility, Tates of Electrode Processes. Electrode Kinetics Model, Cathodic Hydrogen evolution, Depolarisation - Overpotential, Tafel Equation, Ohmic or resistance Over potential, Concentration overpotential, Oxygen Evolution reaction and Decompostion potential, Ionic Transport by Migration, Diffusion and Convection - Mass transfer.

* Able to understand Electric Double Layer theory.

* Able to understand the concepts of Depolarisation and Overpotential.

* Able to understand importance of Tafel Equation.

Unit IV : Kenetics of Corrosion Processes and Evans Diagrams : Electrokinetic phenomenon - Straming potential, zeta potential and Electro - Osmosis, Electrophoresis, Dorn Effect.

Measurements and Systems Analysis : Conductivity measurements - Conductometric analysis - Titrations, Measurements of pH, potential - potentiometric titrations, Polarography Electrogravimetry, Coulometry. Current Distribution in a cell. Rotating Disc Electrode, Rotating Cylinder electrode, Rough Surface Electrode Limiting Current Technique.

* Able to understand the importance of Evans Diagrams.

* Able to understand the concepts of Osmosis and Electrophoresis.

* Able to understand the importance of Conductometric analysis – Titrations.

* Able to understand about potentiometric titrations.

Unit-V: Potential relations in corrosion cells potentials, pH diagrams in corrosion.

Corrosion theory : Manifestation of corrosion, bases of electrochemical corrosion, amount and intensity of corrosion, Eight forms of corrosion : Uniform attack, Galavanic corrosion, crevice corrosion,Pitting, inter granular corrosion. Selective leaching, stress corrosion cracking. Conditions leading to pitting attack., environmental factors, hydrogen damage. Corrosion inhibition and prevention : Domestic water supplies, recirculating water systems, corrosion inhibitors, Inhibitors for acid pickling, vapor phase inhibitors. Coatings and paits: Phosphating, Protective metal coatings; cathodic protection and corrosion of buried structures.

* Able to understand the different forms of corrosion.

* Able to understand the preventive techniques of corrosion.

* Able to understand the concepts of Protective metal coatings.

* Able to understand the application of cathodic protection of buried structures.

Textbooks:

1. An Introduction to Electrochemistry by Samuel Glasstone, D. Van Nostrand Company Inc princeton, Affiliated East-West press Pvt. Ltd.

2. Electrochemistry - Principles and Applications by Edmund C. Fotter Oliver Hume Press Ltd., London.

Reference Books:

1. Electrochemical Engineering, Principles, by Geofferey Prentice, The Johns Hopkins University, Prentice Hall, Englewood Cliffs, New Jersy, 07632.

2. Electrochemistry - Bookris and A.K.Reddy.

3. Electrochemical Engineering by C.L.Mantell.

4. Principles of Electrochemical Engineering by L.W.Shemilt.

5. Chemical Engineering Development Centre, Indian Institute of Technology, Madras 600 036.

6. Fontanna and Grene 'Corrosion Engineering'.

MPE -1.1.4: Elective –II

MPE -1.1.4 A - Elective-II (Corrosion Engineering-I)

Common for M.Tech (Chemical, MPE, IPCE, CACE & Biotechnology)

Objectives :

The main objectives are to provide:

1. Basic aspects of electrochemistry relevant to corrosion phenomena,

2. Importance and forms of corrosion.

3. Knowledge on corrosion rate expressions and measurement techniques.

4. Knowledge on factors influencing corrosion of iron and steel exposed to atmospheric, soil and aqueous medium.

5. Basic knowledge on remedial measures for corrosion.

Outcome:

At the end of the course, the student will be able to

1. Acquires knowledge on basic principles of electrochemistry, importance of corrosion.

2. Predict whether corrosion will occur for a particular environment.

3. Estimate corrosion rates and analyze.

4. Identify the type of corrosion and propose viable remedial measures.

SYLLABUS

Basic Concepts and Outlines of Electrochemistry: Fundamentals of Electrochemical reactions, Faraday's Laws Electrolytic and ionic conductance, ionic mobility's, Transport Nos. Galvanic Cell and Electrolytic cells.

Definition and importance of corrosion, Dry cell, analogy, Corrosion Cells, Types of Corrosion Cells- a) Dissimilar electrode cells b) Concentration cells such as a salt concentration cells, differential aeration cells c) differential Temperature cells. Corrosion Rate Expresions - mdd, ipy, cpy, mpy, etc.

LO1: Choose a specific cell for a given situation

LO2: Identify the type of corrosion cell that will form in that particular environment

Corrosion Tendency and Electrode Potentials: Free Energy changes, Development of Nernst Equation for calculation of Half-cell potentials, Hydrogen electrode, Spontaneity of a reaction, Reversible cells and potentials – convention of Sign and calculations of EMF from standard Equilibrium potentials., EMF Series and Galvanic series, Reference Half Cells – Calomel, Silver-Silver Chloride and Saturated Copper-Copper Sulphate Half Cells. Pourbaix Diagram for Iron, Aluminum and magnesium, limitations of pourbaix diagrams.

LO3: Predict the tendency of corrosion to occur

LO4: Identify the corrosion zones based on pH of media

Polarization and Corrosion Rates: Polarization and a Polarized Cell, Causes of Polarization – Concentration Polarization, Activation Polarization and IR drop. Hydrogen Over potentials, combined polarization and Mixed potential theory. Tafel Slopes and Tafel Equation. Graphical method of expressing Corrosion Reactions (Polarization diagrams/Evans diagrams), Derivation of Stern-Geary Equation, Influence of Polarization on Corrosion rates.

LO5 : Derive the equations for estimating corrosion rates

LO6 : Evaluate and Analyze data for corrosion rates

Passivity: Characteristics of Passivation, Flade potential, behavior of passivators, transpasivity, Theories on Passivity.

Forms of Corrosion: Uniform attack, Galvanic Corrosion, Crevice Corrosion, Pitting, Intergranular Corrosion, Selective Leaching, Erosion Corrosion and Stress Corrosion. Hydrogen damage. Factors influencing, mechanisms and prevention techniques for all forms of corrosion. Calculation of Corrosion rates using weight lost method and Polarization data. Electrochemical Impedance Spectroscopy. Effect of Dissolved Oxygen (Air saturated Water, High Partial Pressure of Oxygen and Anaerobic bacteria), Temperature, pH, Galvanic coupling, velocity, dissolved salts concentration. Wet and dry corrosion.

LO7: Identify the type of corrosion

LO8: Recommend proper remedial measures

Textbooks :

1. Corrosion and Corrosion Control by Herbert, H. Uhlig John Wiley and Sons Inc., New York.

2. Corrosion Engineering by Mars F Fontana, McGraw Hill.

3. An Introduction to Electrochemistry by Samuel Glass stone, Affiliated East West Press Pvt. Ltd.,

Reference Books :

1. Corrrosion Volumes 1 & 2 by L.L. Shrier, Newnes - Butter-worths, London.

MPE - 1.1.4 B - Elective-II (Energy Engineering-I)

Common for M.Tech (Chemical, MPE, IPCE, CACE & Biotechnology)

Objectives:

To lean overview of solar radiation and it's potential for collection to meet the energy needs of mankind and potential for solar energy option. To learn measuring techniques of solar radiation and its compilation.

To learn various design and operational aspects of solar energy collection and storage.

To learn the design and operation of solar energy appliances like liquid flat plate collectors, Solar Air Heaters, Thermal energy storage, Thermal energy storage, Solar Pond, Solar thermal power generation.

To learn theory and application of Photovoltaic cells

Outcome:

The student learns collection and design of various kinds of equipment operated on solar energy. The student learns principles and practice of Photo voltaic cells.

Syllabus

The Solar Energy option : Thermal conversion – collection and storage Thermal applications – photovoltaic conversion – wind energy – Energy from Bio – mass – ocean thermal energy conversion.

Solar Radiation : Solar Radiation outside the earths – atmosphere Solar radiation at the Earth's surface – Instruments for measuring Solar Radiation – Solar Radiation data – Solar Radiation Geometry Empirical equations for predicting the availability of Solar Radiation – Solar radiation on tilted surface.

Liquid flat – Plate Collectors : Components of liquid flat plate – various types of collectors – Performance Analysis – Transmissivity – Absorptivity product – Overall loss coefficients and heat Transfer correlations – Collector efficiency heat removal factors – effect of various parameters on performance. Transient Analysis – Testing procedures.

Solar Air Heaters : Various types of solar Heaters – Performance Analysis of a conventional Air Heater – Testing procedures – Concentrating collectors – various types of concentrating collectors cylindrical and parabolic collectors – General receiver collectors.

Thermal energy storage : Sensible heat storage – Latent heat storage – Thermochemical storage

Solar Pond : Description – Performance analysis – Experimental studies – Operational problems.

Solar Air Conditioning and Refrigeration : Heat pump cycle – Coefficient of performance of the heat pumps – solar air-conditioning with absorption – Refrigeration system (Ammonia water and lithium bromide – water systems).

Solar thermal power generation : Thermal and direct electricity generation – Major sub-stations of a solar thermal power plant, Examples of installed systems – Concentration ratio. Temperature and efficiency concepts – Solar farm and tower – Economics.

Photovoltaic Energy Conversion : Photovoltaic Energy Conversion Fundamentals – band theory of solids – Physical processes in a solar cell – Solar cell with light incidence – Solar cell module – Silicon Solar Cells – Copper Sulphate / Cadmium sulphide Solar Cells.(Banasal et at.,chapters 9;Taylor, chapters 6, pages 256-298.

Text Books:

1. Solar Energy: Principles of thermal collection and storage by S.P. Sukhatme, Tata McGraw Hill, New Delhi 1984 (Chapters 2 to 8)

2. Renewable energy sources and conversion technology by N. K. Bansal, M. Kleemann, Michael Mcliss, 1990 (Chapters 2 – 9).

MPE - 1.1.4 C - Elective-II (Reaction Engineering-I)

Common for M.Tech (Chemical, MPE, IPCE, CACE & Biotechnology)

Unit I : (Scope : J.M. Smith : Chapter 7): Heterogeneous Processes, catalysis, and absorption: Global Rates of Reaction - Types of Heterogeneous Reactions - The nature of catalytic Reactions - The Mechanism of catalytic Reactions - Surface Chemistry and Absorption - Absorption Isotherms - Rates of Absorption.

Unit II (Scope : J. M. Smith: Chapter 8 : Solid Catalysts: Determination of surface area - Void Volume and solid density - Fore volume distribution - Theories of Heterogeneous Catalysis - Classification of catalysts - Catalyst Preparation - Promoters and Inhibitors Catalyst Deactivation (Poisoning).

Unit III: (Scope: J.M. Smith : Chapter 9): Rate equations for fluid - Solid Catalytic Reactions: Rates of adsorption, Desorption, Surface Reaction - Rate equations in terms of Fluid phase concentrations at the catalyst surface - Qualitative analysis of rate equation - Quantitative inter pretation of Kinetic data - Redox Rate equations.

Unit IV: (Scope : Octave Levenspiel : Chapter 15) : Deactivating Catalysts : Mechanism of Catalyst Deactivation - The ratre of equation - The rate of equation from experiment - Batch - solids: Determining the rate for Independent Deactivation Batch - solids : Determining the rate of parellel, series or side - by - side Deactivation - Flowing solids experimental Reactors - Finding the Mechanism of Decay from experiment Design.

Unit V: (Scope : J. M. Smith : Chapter 10) : External transport Processes in Heterogeneous Reactions: Fixed bed reactors - The effect of physical processes on observed rate of reaction - Mass and Heat transfer coefficients (fluid particle) in packed beds - Quantitative treatment of external transport effects - Stable operating conditions - Effect of external transport Processes on selectivity. Fluidised bed reactors - Particle - fluid Mass and Heat transfer Slurry Reactors - Mass transfer coefficients: Gas bubble to liquid (K_1) - Mass transfer coefficients: Liquid to particle

(K_c) - The effect of mass - transfer on observed rates Trickle - Bed reactors - mass transfer coefficients: Gas to liquid ($K_1 a_g$) - Liquid to particle ($k_c a_c$) - Calculation of global rate.

Text Books:

1. Smith. J.M., " Chemical Engineering Kinetics", McGraw Hill book Company, New Delhi (Third Edition) 1981.

2. Octave Levenspiel, " Chemical Reaction Engineering" , Wiley Eastern Limited - Second Edition - 1972.

Reference Books :

1. Thomas, J.M. And Thomas, W.J. " Introduction to the Principles of Heterogeneous Catalysis". Academic Press Inc., New York 1967.

2. Carbnerry, James, J., " Chemical and Catalytjic Reaction - Engineering", McGraw - Hill, Engineering Series.

MPE 1.1.5: RESEARCH METHODOLOGY AND IPR

Common for M.Tech (Chemical, MPE, IPCE, CACE & Biotechnology)

Unit 1: Meaning of research problem, Sources of research problem, Criteria Characteristics of a good research problem, Errors in selecting a research problem, Scope and objectives of research problem. Approaches of investigation of solutions for research problem, data collection, analysis, interpretation, Necessary instrumentations

Unit 2: Effective literature studies approaches, analysis, Plagiarism, Research ethics,

Unit 3: Effective technical writing, how to write report, Paper, Developing a Research Proposal, Format of research proposal, a presentation and assessment by a review committee

Unit 4: Nature of Intellectual Property: Patents, Designs, Trade and Copyright. Process of Patenting and Development: technological research, innovation, patenting, development. International Scenario: International cooperation on Intellectual Property. Procedure for grants of patents, Patenting under PCT.

Unit 5: Patent Rights: Scope of Patent Rights. Licensing and transfer of technology. Patent information and databases. Geographical Indications.

Unit 6: New Developments in IPR: Administration of Patent System. New developments in IPR; IPR of Biological Systems, Computer Software etc. Traditional knowledge Case Studies, IPR and IITs.

References:

1. Stuart Melville and Wayne Goddard, "Research methodology: an introduction for science

2. & engineering students'"

3. Wayne Goddard and Stuart Melville, "Research Methodology: An Introduction"

4. Ranjit Kumar, 2nd Edition , "Research Methodology: A Step by Step Guide for beginners"

5. Halbert, "Resisting Intellectual Property", Taylor & Francis Ltd ,2007.

6. Mayall , "Industrial Design", McGraw Hill, 1992.

7. Niebel , "Product Design", McGraw Hill, 1974.

8. Asimov , "Introduction to Design", Prentice Hall, 1962.

9. Robert P. Merges, Peter S. Menell, Mark A. Lemley, " Intellectual Property in New

10. Technological Age", 2016.

11. T. Ramappa, "Intellectual Property Rights Under WTO", S. Chand, 2008

MPE 1.1.6 A: Audit Course-1
(YOGA FOR WORKING PROFESSIONALS)

Common for M.Tech (Chemical, MPE, IPCE, CACE & Biotechnology)

Course objectives:

1. To make the student understand various practices of yoga and yoga diet.
2. To make the student be familiar with various asanas and other associated practices.
3. To make the student appraise the holistic benefits of yoga
4. To make the student identify a therapeutic solution for common health issues.
5. To make the student experience the pranahuti aided meditation.

Course outcomes:

1. The students will discover the importance of yoga for leading a disciplined way of life.
2. The students would improve their wellness by adapting various yogic practices in their day to day life.
3. The students would perceive the holistic benefits of yoga
4. The students can judge the causes of common diseases and can recommend therapeutic solutions based on yogic practices
5. The student can compare the placebo meditation and meditation with pranhuti.

Unit-I: Introduction to Yoga : The Origins of Yoga – Definitions - Concepts - Aims and objectives of Yoga - Yoga is a Science and Art - Ideal Practice of Yoga in the new millennium. Streams of Yoga - Karma Yoga - Bhakti Yoga - Jnana Yoga - Raja Yoga (Astanga Yoga) - Hatha Yoga - Yoga and Diet - Yoga Disciplined way of life. Difference between Yogasanas and Physical Exercises.

Learning outcomes:

1. After completing this unit, the students will be able to recognize the differences between yogic practices and physical exercises.
2. At the end of this unit, the students will be able assess the relevance of yogic practices for holistic wellness in the contemporary times.

Unit-II: Yogasanas with practical : Loosening the joints- Joint freeing series, Suryanamaskar, Tadasana, Trikonasana, Artha chandrasana, Danurasana, Utkatasana, Dandasana, Pavanamuktasana, Hamsasana, Arthakati chakrasana, Artha chakrasana, Janusirasasana, Vajrasana,

Makarasana, Padmasana, Sukhasana, Natrajasana, Savasana. Introduction to Kriyas, Pranayamas, Bandhas and Mudras.

Learning outcomes:

1. The students will be able to demonstrate some selective yogasanas.

2. The students will be able to appraise the importance of allied yogic practices such as pranayama, mudras, bandhas and kriyas.

Unit-III: Physiological benefits of Yoga : Physiological Benefits of Asanas and Pranayama – Chest Cage – Regulation of Breathing – Types of Breathing. Physiological Benefits of Bandhas – Mudras – Kriyas - Meditation – Nadis – Chakras – Kundalini shakti – Psycho-neuro Immunology. Role of Yoga on Psychological Qualities and Psychological Disorders.

Learning outcomes:

1. By studying this unit, the students will be able to value the physiological benefits of yoga practices.

2. The students will be able to support the role of yoga in the treatment of psychological disorders at the end of this chapter.

Unit-IV: Introduction to Yoga Therapy : Essence and Principles of Yoga therapy- Physiology and Pathology in the yoga – Shatra- koshas – doshas- Granthis – Pancha prana – Application of Yoga and its types- Methodology in Yoga Therapy – Factors (Heyam, Hetu, Hanam and Upayam) - Methods (Darsanam, Sparsanam, Prasnam, Nadi, Pariksa) Examination of Vertebra, joints, Muscles, Abdomen and Nervous system and therapeutic applications – Modification of yogic practices for Human Systems- Yogic diet.

Learning outcomes:

1. At the end of the unit, the students become familiar in assessing the health of an individual.

2. After completing this unit, the students can recommend appropriate yoga therapy for health problems faced by an individual.

Unit-V: Meditation : (The student has to maintain a diary to record his observations during meditation. This diary will help him to understand the extent of his progress) Meaning and Concept of Meditation – Need of meditation- techniques of meditation-Tools of meditation-Advantages of Meditation- Experience of meditation- Obstacles. Sahaj Marg Meditation, Heartfulness movement. Elements of sahaj marg meditation: Prayer, cleaning, sitting, satsang, universal prayer and suggestions. Ten maxims of sahaj marg.

Learning outcomes:

1. The student will be well versed in the benefits of meditation at the end of the unit.

2. The student can experience the difference in normal situation and meditative condition after experiencing pranahuti aided meditation.

Reference books

1. George Feuerstein: The Yoga Tradition (Its history, literature, philosophy and practice).

2. Georg Feuerstein. The Psychology of Yoga: Integrating Eastern and Western Approaches for Understanding the Mind.

3. Swamy Satyananda Saraswathi: Asana, Pranayama, Mudra, Bandha (India: Yoga Publications Trust, Munger, Bihar).

4. Swami Sivananda : Practice of Yoga (The Divine Life Society, Shivananda Nagar.P.O.,U.P. Himalayas, India).

5. Krishna Raman: A Matter of Health (Integration of Yoga and western medicine for prevention and cure) (Chennai East West Books(Madras) Pvt. Ltd.,1998.

6. Bhavanani, A.B. (2011): Application of Yoga Concept in the Health Improvement. In: P.Nikic, ed.

7. Ram Chandra, Complete works or Ram Chandra (Babuji) Vol. I, Sri Ram Chandra Misssion, SPHT, Calcutta.

MPE 1.1.6 B- Audit Course -I Organizational Behavior

Common for M.Tech (Chemical, MPE, IPCE, CACE & Biotechnology)

UNIT-I: Organizational Behavior: Concept of Organization - Concept of Organizational Behavior - Nature of Organizational Behavior - Role of Organizational behavior - Disciplines contributing to Organizational Behavior.

UNIT-II: Motivation: Definition - Nature of Motivation - Role of Motivation - Theories of Motivation: Maslow's Need Hierarchy Theory, Herzberg's Motivation Hygiene Theory and McGregor's Theory X and Theory Y.

UNIT –III: Group Dynamics: Meaning - Concept of Group - Types of groups -Formal and Informal groups - Group development - Group cohesiveness and factors affecting group cohesiveness.

UNIT-IV: Leadership: Concept of Leadership - Difference between Leadership and Management - Importance of Leadership - Leadership styles: Autocratic leadership, Participative leadership and Free Rein leadership.

UNIT-V: Communication: Meaning - Communication Process - Forms of communication: Oral, Written and Non- Verbal communication - Direction of communication: Downward, Upward and Horizontal communication.

UNIT-VI: Organizational conflicts: Concept of conflict - Reasons for conflict - Types of Conflict: Intrapersonal conflict, Interpersonal conflict, Intragroup conflict, Intergroup conflict, Inter organizational conflict - Conflict management.

UNIT –VII: Organizational Change: Nature - Factors in Organizational change -Planned change: Process of planned change - Resistance to change: Factors in resistance to change - Overcoming resistance to change.

Text Books.

1.L.M.Prasad: Organizational Behavior, Sultan Chand & Sons, New Delhi -110002

2.K. Aswathappa: Organizational Behavior, Himalaya Publishing House, New Delhi

Reference Books.

1. Stephen Robbins: Organizational Behavior, Pearsons Education, New Delhi.

II SEMESTER

MPE-1.2.1 - MINERAL PROCESS ENGINEERING

Objectives: Identification of ores and their constituents. Identification of various aspects of liberation and separation methods. To know various aspects of comminution like- principles of comminution, classification and operation of comminution equipment, industrial practice. To know the methods of laboratory sizing practice and industrial aspects of sizing equipment. To know Classification principles and application operation of mineral processing equipment.

Outcome: Able to know various aspects of comminution and their equipment.

Syllabus:

1. a) Concept of Mineral and ore: b) Constituents of ore - Chief minerals, associated minerals, rare minerals - elements in solid solution and gangue minerals; c) Mineral Processing - Scope, and objective; d) Liberation and separation Processes depending on physical including surface properties of minerals.

2. Size reduction: a) Crushing - Characteristics of Jaw and gyratory crushers, cone crushers, crushing rolls and stamp mills; b) Grinding - Rotary mills - Ball, tube and rod mills Fluid Jet pulverisers and vibration mills; c) Batch, continuous, open and closed circuit grinding.

3. a) Sizing and size determination in the laboratory by screening and its classification and sedimentation techniques, graphical presentation of date of size analysis; b) Reduction ratio, average particle size and surface area calculation ;. c) Industrial sizing and equipment.

4. Attributes of communication, laws of crushing - Rittinger, Kicks and Bond's laws, work index and relative crushing efficiency and their applicability in industry.

5. Principles of flow of solids in fluids - Stocks and Newton's equation, free and hindered settling and their application in classification for thickening, sorting and sizing including the relevant equipment.

Text Book :

Principles of Mineral Dressing by A.M. Gaudin and E.J. Pryior.

MPE-1.2.2: Process Dynamics & Control
(Common for MPE, CACE & IPCE)

Objectives :

The main purpose of teaching Process Dynamics & Control for first year postgraduate students is to take the student from basic mathematics to a variety of design applications in a clear, concise manner. This course is focused on the use of the digital computer in complex problem solving and in process control instrumentation. For chemical engineering problem solving students need more advanced mathematical preparation like partial differential equations, linear algebra and Fourier series all are introduced in this course.

Outcome:

* Able to know the sampled data control systems consists of sampling and advanced mathematical model Z- transforms.

* Able to describe the process in which the flow of the signals is interrupted periodically like in chromatograph.

* Able to calculate the open loop response of a sampled data system and can develop a pulse transfer function that is the counterpart of the transfer function for continuous systems.

* Able to know the sophisticated instruments used for the analysis of water and air pollutants, The student should have knowledge to design the equipment used for the abatement of these pollutants.

* In a position to modernize the solid waste management and the student must be in a position to get awareness on accidents that are occurring in industries during handling, storage, and manufacturing of chemicals, remedial measures to arrest the accidents immediately.

SYLLABUS

Unit-1 : Review of time domain, Laplace domain and frequency domain dynamics of process and control system.

Learning outcomes

* Able to know the sampled data control systems consists of sampling and

* Able to solve the problems related to Laplace domain and frequency domain dynamics of process and control system.

Unit-2 : Sampled data control system – sampling and Z–Transforms , open loop and closed loop response, Stability.

Learning outcomes

* Able to solve the problems related toSampled data control system – sampling and Z–Transforms ,

* Able to calculate the open loop response of a sampled data system and stability

Unit-3 : State space methods – representation of physical systems – transfer function matrix – Multivariable systems – Analysis and control.

Learning outcomes

* Able to solve the problems related toState space methods – representation of physical systems and Student can develop a pulse transfer function that is the counterpart of the transfer function for continuous systems.

* Able to solve the Design Multivariable control systems – Analysis and control.The student should have knowledge to design the equipment used for the abatement of these process control systems.

Unit-4 : Non linear control –examples of non linear systems – Methods of phase plane analysis.

Learning outcomes

* Able to solve the problems related toNon linear control systems

* Able to solve the problems related toexamples of non linear systems and also develops Methods of phase plane analysis.

Unit-5 : Control of heat exchangers, distillation columns and Chemical Reactors.

Learning outcomes

* Able to solve the problems related toControl of heat exchangers, distillation columns and

* Able to solve the problems related toChemical Reactors.

Textbooks:

1. Process system Analysis and control, 2nd edition, Donald R Coughanower and Koppel.

2. Automatic process Control by Peter Harriot.

3. Process Modeling, Simulation and control for Chemical Engineers by W.L. Luyben.

MPE-1.2.3- PROCESSING OF ORES

Objective:

The course titled 'Processing of Ores' is designed to meet the objective that the students will understand various aspects pertaining to its origin, occurrence and enhancement of grade & yields and also the appropriate methods/techniques for eco friendly exploitation of different ore deposits.

Outcome:

1. After completion of this course the students will gain proper knowledge on suitable options of processing techniques

2. Development of skills in modification of process flow sheets.

3. Knowledge in prudential utilization and conservation of mineral resources,

4. Brightening the opportunities for their employability.

5. Base for taking up research work for innovation of more feasible techniques for optimization of production, energy consumption and environmental pollution control etc.

SYLLABUS

I. Introduction: Principles of ore formation – magmatic segregation deposits – pegmatite deposits – igneous metamorphic deposits – hydrothermal deposits – sedimentary deposits – supergene sulphide deposits

II. Mineral beneficiation techniques: Size reduction – Screening – Separation of solids suspended in fluids –Froth flotation – Separation of solids from fluids – Magnetic and Electrostatic separation Methods

III. Beneficiation of metallic ores: Iron ores – Manganese ores – Copper ores – Lead & Zinc deposits – Bauxite deposits – Chromite deposits

IV. Beneficiation of non- metallic ores: White stone deposits – Refractory Materials – silica - feldspar – clays - Mica - asbestos – gypsum – pyrites – rock phosphate – coal & lignite

V. Beneficiation of precious metals and beach sands: Gold deposits – diamond deposits – beneficiation of uranium deposits, Beach sand - Ilmenite, Rutile, Zircon, Garnet, Monazite, Silliminate, etc.

Textbook: "Ore deposits of India -their distribution and processing" by K.V.G.K. Gokhale and T.C.Rao

References: The Practice of Mineral Dressing by F.B Michell, Class notes and Mining & Mineral Dressing Journals.

MPE-1.2.4 - Elective-III

MPE-1.2.4 A- ELECTIVE-III (Analytical Techniques)

Objectives:

To understand the different types of analysis methods used in chemical industries. The course consists of both chemical and instrumental methods and also both qualitative and quantitative methods of analysis. In this course, the chemical methods of quantitative analysis include all the aspects such as: selection and sampling of materials, preparation of solutions, and analysis of various chemical raw materials and products. In instrumental methods colorimetric, spectrophotometric, spectrographic, flame emission, photo meter have been discussed.

Outcome:

* The student should be able to know the theory of sampling, selection and preparation of the sample.

* The student should be able to know the sophisticated instruments used for the analysis of mineral ores and chemical samples. The student should have knowledge of analysis for the ores and chemical samples.

* The student should be in a position to understand the operation of instruments like X- Ray, flame emission spectroscopy.

* The student can determine the traces of elements in the metals and alloys required for specific application.

SYLLABUS

Unit-1 : Theory of sampling, sampling of ores, minerals and coals, proximate and ultimate analysis of coal; coking index, calorific value of coal, its determination and calculation, analysis of ash,

Learning outcomes

* The student should be able to know the theory of sampling

* Selection and preparation of the sample. And coal

Unit-2 : Wet assaying of ores of iron, copper, lead, zinc and manganese, dry assaying process, fire saving methods for gold and silver,

Learning outcomes

* The student should be able to know the theory of samplingWet assaying of ores of iron, copper, lead, zinc and manganese able to determine the metals and alloys required for specific application

* The student can determine the traces of elements and also The student should be able to know the theory of dry assaying process, fire saving methods for gold and silver,

Unit-3 : Instrumental methods of mineral investigation: Theory and techniques of colorimetry and absorptiometry, photometer, spectrophotometers, atomic absorption spectrophotometer,

Learning outcomes

* The student should be able to know the sophisticated instruments used for the analysis of mineral ores and chemical samples Theory and techniques of colorimetry

* The student should be able to know the sophisticated instruments used for the analysis of mineral ores and chemical samples Theory and techniques of photometer, spectrophotometers, atomic absorption spectrophotometer

Unit-4 : Electrochemical methods of analysis, Electrogravimetry methods, potentiometric titration, polarography, DTA,

Learning outcomes

* The student should be able to know the sophisticated instruments used for the analysis Electrochemical methods of analysis,

* The student should be able to know the sophisticated instruments used for the analysis Electrogravimetry methods, potentiometric titration, polarography. And The student should have knowledge of analysis for the ores and chemical samples.

Unit-5 : X-ray techniques, emission of X-rays, X-rays instrumentation, X-ray diffraction, flame emission spectroscope - source, equipment and application of emission spectroscopy.

Learning outcomes

* The student should be able to know the sophisticated instruments used for the analysis X-ray techniques, emission of X-rays, X-rays instrumentation, X-ray diffraction,

* The student should be able to know the sophisticated instruments used for the analysis flame emission spectroscope - source, equipment and application of emission spectroscopy

Reference books:

1. 'An Introduction of Metallurgical Analysis: Chemical & Instrumental' by S.K. Jain Vikas Publishing House.

2. 'A Text Book of Metallurgical Analysis' by B.C.Agarwal & S.P.Jain, Khanna Publications.

3. 'A Text Book of Quantitative Inorganic Analysis' by A.I.Vogel, ELBS Edition.

MPE-1.2.4 B – ELECTIVE-III (Process dynamics and control-II)

Objectives :

The main purpose of teaching Process Dynamics and Control as elective-II for M. tech second year postgraduate students is to make them to understand the unity in outlook that has been lacking in the field of chemical reactor design. The stability viewpoint does in a sense in diverse areas like stirred tank reactor, plug flow reactor. The course in common emerge as qualitative description of the behavior of the respective models, for the stability viewpoint deals with certain structural aspects present in both problems.

Outcome:

* The student should be able to know a brief introduction about the most common chemical reactor models. The subject of steady state multiplicity in stirred tank reactors and develops uniqueness criteria for various cases that may be of interest for design.

* The student should be able to know the interpretation of terms such as steady and stable. The student should have knowledge to explore the implications of the stability concept in dealing with finite disturbances of practical magnitude.

* The student should be in a position to analyze from ordinary differential equation models to partial differential equation models.

* The student should be in a position to understand the steady state multiplicity, local stability, and regional stability are treated for distributed systems.

SYLLABUS

Unit I :Mathematical modeling of reactors - Mass and energy balance equations for CSTR,PFTR, TRAM, TRRM, catalyst particle - multiphase models. Lumped parameter model - steady state multiplicity of a CSTR- Van Herden diagram - criteria for uniqueness of steady state for isothermal and temperature dependent reactors and multiphase systems - design consideration.

Learning outcomes

* The student should be able to know a brief introduction about the most common chemical reactor models and Mathematical modeling of reactors

* The student should have knowledge to explore the subject Lumped parameter model design.

Unit II : Geometry of dynamics for a lumped parameter model - stable and unstable steady states - phase plane for the CSTR and eigen values - linear second order system and eigen vector - Liapunov stability criterion and Liapunov functions - fundamental linearization theorem - local stability and steady state operating curves for a temperature - dependent reactor.

Learning outcomes

* Able to solve the problems related to Geometry of dynamics for a lumped parameter model Able to calculate the open loop response of a sampled data system and stability

* The student should be in a position to analyze from Liapunov stability criterion and Liapunov functions

Unit III : Region of asymptotic stability and v-function in x-space - Krasovskil's theorem and V-function in f-space.

Learning outcomes

* Able to solve the problems related to Region of asymptotic stability and v-function in x-space and Student can develop a

* Able to solve the Design Krasovskil's theorem and V-function in f-space.The student should be in a position to understand the steady state multiplicity

Unit IV : Steady states in distributed parameter systems - uncoupling the energy and mass balances for TRAM model - Steady state models of a PFTR and parametric sensitivity - Steady state multiplicity of a TRAM and catalyst particle model - uniqueness criteria for fixed bed reactors.

Learning outcomes

* Able to solve the problems related to Steady states in distributed parameter systems -Able to solve the problems related to examples of non linear systems and also develops Methods of phase plane analysis.

* The student should be in a position to understandSteady state models of a PFTR and parametric sensitivity - Steady state multiplicity of a TRAM

Unit V : Local stability of distributed parameter systems - the techniques of linearization of nonlinear differential equations and uncoupling of certain transient conservation equations - applications of these techniques to the cases of catalyst particle and TRAM.

Methods of solution of transient mass and energy balance quations applied to catalyst particle model and TRAM - Galerkin method - Collocation method.

Learning outcomes

* Able to solve the problems related to Local stability of distributed parameter systems - the techniques of linearization of nonlinear differential equations and uncoupling of certain transient conservation equations - applications of these techniques to the cases of catalyst particle and TRAM.

* Able to solve the problems related to Methods of solution of transient mass and energy balance equations applied to catalyst particle.

Text Book:

Stability of Chemical Reactors by Daniel D. Perlmutter, John Weily and Sons Inc. (New York, (1976).

MPE-1.2.4 C- ELECTIVE-III (Electro Chemical Engineering-II)

Objectives:

The main objectives are to provide

1. Knowledge on Electroplating, Electroforming, electro refining, electro wining.
2. Knowledge on Electrolysis and Manufacturing process.
3. Knowledge on primary & secondary batteries and fuel

Outcome:

At the end of the course, the student will be able to

1. Explain different electrochemical ore beneficiation techniques, electroplating, electro refining and electro winning.
2. Take part in commercial and industrial manufacturing units using electrolysis.
3. Design, test and evaluate batteries e.g. Primary and secondary batteries, charge/discharge cycles, overpotential, battery capacity, state of charge, state of health, impedance.
4. Construct, Compare and test Fuel cells.

SYLLABUS

Part –A

Electroplating, Electroforming and Electrophoresis

Electrorefining of metals - Copper, Silver, Gold, Nickel, Lead and Cobalt.

Electrowinning of metals - Copper, Zinc, Cadmium, Chromium and Manganese.

LO1: Appraise various metal extraction procedure by electrochemical means

LO2: Recommend the process conditions

Electrolysis of Alkali Halides and Sulfates - Chlorine and Caustic, Potassium halides, Hydrochloric acid, Fluorine and sodium sulfate. Manufacture of Hydrogen and Oxygen. Electrolytic Reduction and Oxidation - Persalts, Cuprous oxide, Mercuric oxide, Manganese dioxide and Perchlorates. Electrolysis of fused Salts - Aluminum, Magnesium, Sodium, Beryllium and Zirconium.

LO3: Choose appropriate manufacturing processes of ionic salts by electrochemical schemes

LO4: Compare different sets of conditions for the manufacture of a given salts

Part –B

Batteries: Classification of cells and batteries, theoretical cell voltage, capacity, energy, electrochemical principles and reactions

Primary batteries: Zinc carbon batteries (Leclanche and Zinc chloride cell system), Magnesium and Aluminum batteries, Alkaline manganese dioxide batteries, Lithium batteries.

Secondary batteries: Lead acid batteries, nickel cadmium batteries, nickel metal hydride batteries, lithium ion batteries, rechargeable zinc, alkaline, manganese dioxide batteries

LO5: Evaluate the working behavior of different batteries

LO6: Estimate the charge discharge characteristics of a battery

Fuel cells: Molten carbonate fuel cell(MCFC), phosphoric acid fuel cell(PAFC), Solid oxide fuel cell (SOFC), proton exchange membrane fuel cell(PEMFC).

LO7: Assess the working of different Fuel cells

LO8: Construct and test of Fuel Cell

Textbooks:

1. Electrochemical Engineering by Mantell, C.L. McGraw–Hill
2. Electrochemistry Principles and Applications Edmund Potter, Cleaver–Hume Press Ltd.
3. Handbook of batteries by David linden and Thomas B Reddy, McGraw –Hill

CHEM-1.2.5- ELECTIVE-IV

MPE-1.2.5 A-ELECTIVE-IV (Corrosion Engineering-II)

Common for M.Tech (Chemical, MPE, IPCE, CACE & Biotechnology)

Objectives:

* To enable the principles of corrosion, common corrosion forms, uniform, galvanic, pitting, inter granular, crevice, dezincification, stress corrosion, corrosion fatigue, hydrogen embrittlement corrosion control methods, and material selection to reduce corrosion cost.
* To enable the ability to understand electrochemical fundamentals
* To enable the ability to understand corrosion preventing methods

Outcome:

* The student would know application of weight loss method
* The student would know application of cathodic protection, anodic ptotection
* At the end of this course, the student would know effective surface preparation of specimen can be done

* After completion of this course, the student would understand the causes and the mechanisms of various types of corrosion, including uniform corrosion, galvanic corrosion, crevice corrosion, pitting corrosion, intergranular corrosion.

* The student would know application of Corrosion Processes and Evans Diagrams and application of electroplating, coatings and importance of inhibitors.

SYLLABUS

Corrosion in selective environments: Marine, Acids (Sulfuric acid, Hydrochloric acid, Nitirc acid, Phosphoric acid) Biological and industrial gases (SO_2H_2S).

* Able to understand corrosion and its mechanism in marine atmosphere.

* Able to understand corrosion in acidic media like Sulfuric acid, Hydrochloric,etc.

Corrosion Testing - Purposes, Materials and specimen. Surface preparation, Measuring and weighing , Exposure Techniques - duration, Planned - Interval Tests, Aeration, cleaning specimens after exposure, Temperature, Standard expression for corrosion rates - Galvanic Corrosion, Erosion Corrosion, crevice Corrosion, Intergranular corrosion, test for stainless steels, warren test pitting, stress corrosion, Paint tests, Sea Water tests, Presenting and summarizing data - Nomo graph for corrosion rates and interpretation of results.

* Able to understand the importance of surface preparation.

* Able to understand the application of Standard expression for corrosion rates using weight loss method.

* Able to understand the application of different corrosion tests.

Cathodic and anodic protection, surface preparation for coatings and chemical conversions: Degreasing, Descaling , Polishing - Anodized coating : anodizing oxidizing, chromate coating, phosphate coatings - Metallic coatings : Hot dipping, cementation, vapor deposition of metallic coating; Sprayed coatings: flame spraying plasma spraying, Galvanizing - Electroplating : Nickel & chromium coatings, chromizing.- Organic coatings : paints, enamels, lacquers, resin mixtures.

* Able to understand the application of Cathodic and anodic protection.

* Able to understand the uses of Degreasing, Descaling , Polishing.

* Able to understand the importance of Hot dipping, cementation, vapor deposition of metallic coating. Linings, laminates, reinforced plastic, fibre glass - Corrosion inhibitors: mechanism of inhibition, recirculating of water of water systems.

* Able to understand the importance of Corrosion inhibitors and mechanism of inhibition. Measurement and testing of preventive coatings ; Thickness and Resistance tests for anodized, Painted, electroplated surfaces using polarization resistance, Linear polarization, curve fit analysis and Electrochemical impedance spectroscopy.

* Able to understand the Thickness and Resistance tests.

* Able to understand the linear polarization and curve fit analysis.

Reference books :

1. Mars G.Fontana - Corrosion Engineering

2. Burns, R.M., Bradley, W.W., 'protective coatings for Metals.' Chapters 2 to 18.

Reference Books :

Corrrosion Volumes 1 & 2 by L.L. Shrier, Newnes - Butter-worths, London.

MPE- 1.2.5 B - Elective-IV (Energy Engineering-II)

Common for M.Tech (Chemical, MPE, IPCE, CACE & Biotechnology)

Course objectives:

1. The student is provided with the fundamentals of renewable energy processes.
2. Basic information to comprehend the various non-conventional energy systems would be illustrated to the student.
3. Various ways of obtaining energy from ocean can be demonstrated to the student.
4. The methods of energy conservation and the opportunities for conservation would be emphasized.
5. Economics involved in the energy production processes would be enumerated to the student.

Course Outcomes:

1. Methods to be adopted to utilize biomass as an important energy source
2. Application of thermodynamics to obtain energy from various sources
3. Possible mechanism to draw energy from wind and other natural resources
4. Knowledge about energy conservation and storage
5. Emerging technologies to produce energy such as thermionics, thermoelectricity etc.

SYLLABUS

Fundamentals of energy science and technology: Introduction – Energy, economy and social development – Oil crisis of 1973 – classification of energy sources – consumption trend of primary energy resources – importance of non-conventional energy sources – energy chain – common forms of energy –

advantages and disadvantages of conventional energy sources – salient features of non-conventional energy sources – energy densities of various fuels – environmental aspects of energy – The United Nations Framework Convention on Climate Change – Energy-environment-economy – World energy status – energy scenario in India. Energy conservation and efficiency: Introduction – important terms and definitions – important aspects of energy conservation – global efforts, achievements and future planning – energy conservation/efficiency scenario in India – energy audit – energy conservation opportunities – cogeneration – combined cycle plants. Energy storage: Introduction – necessity of energy storage – specifications of energy storage devices – energy storage methods.

Learning outcomes:

1. The student can identify the ways and means of conservation of energy once the student completes learning this unit.

2. The student can appraise the necessity of energy storage and recommend the methods for energy storage at the end of the unit.

Wind energy: Introduction – origin of winds – nature of winds – wind turbine siting – major applications of wind power – basics of fluid mechanics – wind turbine aerodynamics – wind turbine types and their construction – wind energy conversion systems – wind-diesel hybrid system – effects of wind speed and grid condition – wind energy storage – environmental aspects – wind energy program in India.

Learning outcomes:

1. By studying this unit, the students will be able to predict where the wind power plants can be located.

2. At the end of this unit, the students can recommend appropriate technology for obtaining geothermal energy in a given situation.

Biomass: Introduction – Photosynthesis process – usable forms of biomass, their composition and fuel properties – biomass resources – biomass conversion technologies – urban waste to energy conversion – biomass gasification – biomass liquefaction – biomass to ethanol production – biogas production from waste biomass – energy farming. Geothermal energy: Introduction – applications – origin and distribution of geothermal energy – types of geothermal resources – analysis of geothermal resources – exploration and development of geothermal resources – environmental considerations – geothermal energy in India.

Learning outcomes:

1. After completing this unit, the students will be able to choose appropriate biogas plant for a given location and able to provide dimensions of the same.

2. At the end of this unit, the students will be able to recommend a process for utilizing the biomass for a given application.

Ocean Energy: Introduction: Tidal energy – wave energy – ocean thermal energy. Small hydro resources: Introduction – advantages and disadvantages of small hydro schemes – layout of a micro-hydroscheme - water turbines – turbine classification, characteristics and selection – generators – present status.

Learning outcomes:

1. At the end of this unit, the students can recommend appropriate technology for obtaining energy from ocean in a given situation.

2. Suitable scheme for generating electricity from small hydroresources can be suggested by the student after the completion of this unit.

Emerging technologies: Introduction – fuel cell – hydrogen as energy carrier. Miscellaneous non-conventional energy technologies: Introduction – magneto hydrodynamic power conversion – thermoelectric power generation – thermionic power conversion. Financial and economic evaluation: Introduction – basic terms and definitions – calculations for the case of single payment – calculation for uniform series of payments – calculations for uniform gradient series of payments – calculations for geometric gradient series of payments – effect of inflation on cash flows – comparative economic evaluation of alternatives – effect of depreciation and tax on cash flow.

Learning outcomes:

1. New technologies for obtaining energy from various renewable sources can be evaluated by the student.

2. Economic factor in the energy production by various technologies can be compared by the student at the end of this unit.

Text book:

Non-Conventional Energy Resources by B.H. Khan, 3/e, McGraw Hill (2017).

Reference book:

Fundamentals of Renewable Energy Processes by Aldo V. Da Rosa. Elsevier (2005).

MPE- 1.2.5 C - Elective-IV (Reaction Engineering-II)

Common for M.Tech (Chemical, MPE, IPCE, CACE & Biotechnology)

SYLLABUS

UNIT - I : Laboratory Reactors - Interpretation of Experimental Data - Interpretation of Laboratory Kinetics Data - Homogeneous and Heterogeneous Laboratory Reactors. Calculation of Global Rate - The structure of Reactor Design. (Scope: Chapter 12 of J.M Smith 3rd Edition)

UNIT - II : Design of Heterogeneous Catalytic Reactors Isothermal and Adiabatic Fixed Bed Reactors Non-isothermal, Non-adiabatic Fixed Bed Reactors. (Scope: Chapters 13.1 - 13.9 of J.M Smith 3rd Edition)

UNIT - III : Design of fluidized bed Reactors - Two -Phase Fluidized Bed model - Operating characteristics - Slurry Reactors - Trickle - Bed Reactors - Optimization. (Scope: Chapter 13.10 - 13.13 of J.M Smith 3rd Edition.)

UNIT - IV : Fluid - Solid Noncatalytic Reactions - Design concepts - Single Particle Behavior - Reactor Models. (Scope: Chapter 14 of J.M Smith 3rd Edition)

UNIT - V : Short notes from the portions of all the above four units. Four bits are to be answered out of 7 bits (Not more than 2 bits to be given from any one Unit).

Text Book: Chemical Engineering Kinetics by J.M Smith, McGraw - Hill Book Company , 1980, 3rd Edition.

CHEM 1.2.6: AUDIT COURSE -2

MPE 1.2.6 A : DISASTER MANAGEMENT (Audit Course -2)

Common for M.Tech (Chemical, MPE, CACE, IPCE, Biotechnology)

Introduction to Disaster: Definition, Factors And Significance; Difference Between Hazard And Disaster; Natural And Manmade Disasters: Difference, Nature, Types and Magnitude.

Repercussions Of Disasters And Hazards: Economic Damage, Loss of Human And Animal Life, Destruction Of Ecosystem. Natural Disasters: Earthquakes, Volcanisms, Cyclones, Tsunamis, Floods, Droughts And Famines, Landslides And Avalanches, Man-made disaster: Nuclear Reactor Meltdown, Industrial Accidents, Oil Slicks And Spills, Outbreaks Of Disease And Epidemics, War And Conflicts.

Disaster Prone Areas in India Study Of Seismic Zones; Areas Prone To Floods And Droughts, Landslides And Avalanches; Areas Prone To Cyclonic And Coastal Hazards With Special Reference To Tsunami; Post-Disaster Diseases And Epidemics

Disaster Preparedness And Management Preparedness: Monitoring Of Phenomena Triggering A Disaster Or Hazard; Evaluation Of Risk: Application Of Remote Sensing, Data From Meteorological and Other Agencies, Media Reports: Governmental And Community Preparedness.

Risk Assessment Disaster Risk: Concept and Elements, Disaster Risk Reduction, Global and National Disaster Risk Situation. Techniques of Risk Assessment, Global Co-Operation In Risk Assessment and Warning, People's Participation In Risk Assessment. Strategies for Survival

Disaster Mitigation Meaning, Concept and Strategies Of Disaster Mitigation, Emerging Trends In Mitigation. Structural Mitigation And Non-Structural Mitigation, Programs Of Disaster Mitigation In India.

REFERENCES:

1. R. Nishith, Singh AK, "Disaster Management in India: Perspectives, issues and strategies "'New Royal book Company.

2. Sahni, PardeepEt.Al. (Eds.)," Disaster Mitigation Experiences and Reflections", Prentice Hall Of India, New Delhi.

3. Goel S. L., Disaster Administration And Management Text And Case Studies",Deep & Deep Publication Pvt. Ltd., New Delhi.

MPE 1.2.6 B: ENTREPRENEURSHIP (Audit Course -2)

Common for M.Tech (Chemical, MPE, CACE, IPCE, Biotechnology)

Unit -I : Basic Concepts of Management:Management :- Definition, Nature and Importance ; Functions of the Management; Levels of Management; F.W Taylor's Scientific Management; Henry Fayol's Principles of Management.

Unit-II : Forms of Business Organizations: Introduction, Types of Business organizations: Private Sector- Individual Ownership , Partnership, Joint stock companies and Co-Operative organizations; Public sector- Departmental Organizations, Public Corporations and Government Companies; The Joint sector Management.

Unit-III Production and operations Management: Plant location- Factors to be considered in the selection of Plant location; Break - even analysis-Significance and managerial applications; Importance of Production Planning and Control and its Functions; Human Resource Management and Functions of Human Resource Manager (in brief); Functions of Marketing; Methods of Raising Finance.

Unit-IV : Entrepreneurship: Definition, Characteristics and Skills, Types of Entrepreneurs, Entrepreneur vs. Professional Managers, Growth of Entrepreneurs, Nature and Importance of Entrepreneurs, Women Entrepreneurs, Problems of Entrepreneurship.

Unit-V : Entrepreneurial Development and Project Management: Institutions in aid of Entrepreneurship Development, Idea generation: Sources and Techniques; Stages in Project formulation; Steps for starting a small enterprise - Incentives for Small Scale Industries by Government.

Text Books:

1. Sharma, S.C, and Banga, T.R., Industrial Organization & Engineering Economics, Khanna Publishers, Delhi, 2000.

2. Vasant Desai, The Dynamics of Entrepreneurial Development and Management (Planning for future Sustainable growth), HImalayan Publishing House, 2018.

Reference Books:

1. Aryasri, A.R., Management Science, McGraw HIll Education (India Private Limited, New Delhi 2014.

2. Sheela, P. and Jagadeswara Rao, K., Entrepreneurship, Shree Publishing House, Guntur,

III SEMESTER : MPE-2.1.1: Elective –V

MPE-2.1.1 A - COAL PREPARATION

Objective:

* To get total insight on "coal" , its origin and formation, industrial uses and different techniques available to screen the coal in order to use in various industries.

Outcome:

* Well versed knowledge on basic concepts including origin and formation of coal and its preparation for various industrial applications.

* Knowledge on the important screening methods and classification methods.

* Knowledge on coal and its industrial uses, which helps MPE specialization student to work in the coal related industry.

SYLLABUS

1.Origin and formation of coal of Insitu and drift origin Classification of coal Goudwana coals and their distribution. Lignites and anthracites and their distribution.

2. Composition of coals Ash in coals (3) Ultimate and proximate analysis of coal coking coals, mining and stock poling and industrial utility of different types of coal.

1. Testing of coal, sink and fioat tests, washability curves.

2. Coal preparation - Principles in dry and wet methods. Washing techniques and methods, equipment and effidrence callculations.

3. a) Special types of crushers, screens and other equipment used in coal washeries for conveyance, dewatering and such other. Auxillary operation ; (b) Choice, selection, operation, maintenance instrumentation and automation in coal washeries.

Reference Books:

Chemical Engineers Practice, Vol. 3.

Solid systems, Edited by H.W. Cremer and T. Davis and Journals.

MPE-2.1.1 B – ADVANCE MINERAL ENGINEERING

OBJECTIVE:

Mineral Process Engineering course deals with various process for upgrading the original ores. Concentration of ore is an important section of mineral recovery. After successfully completing the course Mineral Process Engineers can know the various ores and their properties and various concentration methods. This is very useful course for Mineral Engineers.

OUTCOME:

1.Under stand the process of Heavy Media Separation and its applications

2. Understand the process of Jigging and Tabling and its applications

3. Know the Electro static and Magnetic Separation and its applications

4. Understand the phenomenon Flotation Technique and its applications in industries

5. Understand the basic operation of Thickening and Filtration and Cyclone Separation operations

SYLLABUS

1. Heavy media separation processes Materials for media, characteristics of media Industrial processes Equipment and flow sheets.

2. a) Principles of flowing film concentration - Tabling Wilfley Table and Prematric tabling and agglomeration tabling.

b) Application of Principles of hindered settling defferntial acceleration and consolidation trickling - Typical hydraulic jigs and Prematric jigs.

3. Principles of magnetic and electro-separation process and equipment.

4. a) Flotation and agglomeration - Surface energy, absorption, contact angle and other physical aspects. b) Flotation Chemical aspects - Chemical reagents in flotation; c) Flotation technology different types of cells and Practice.

5. a) Miscellaneous Processes of benefication - Cyslone classifiers, hydrcyclone, spiral and hydraulic classifiers; b) Flow -sheet - Selection of process and machinery.

Text Book:

Principles of Mineral Dressing by A.M. Gaudin & E.J. Prior.

MPE-2.1.1 C : Elective-V (Process Modeling and Simulation)

Common for M.Tech (Chemical, MPE, CACE & IPCE)

Objective:

Deals with writing various process models based on basic physical process. It also deals with solving the various models by means of numerical methods by computer simulation. By studying this course, one can simulate various chemical processes by computer simulation.

Outcome:

1. Understand the writing of a model of a process based on basic physical processes like mass, momentum and energy balances.

2. Able to develop a model equation for Tanks, Isothermal and Non-Isothermal Systems

3. Able to understand the models for binary distillation column, batch reactors, etc.

4. Able to solve the model equations by numerical methods.

SYLLABUS

Principles of formulation - Continuity equations – Energy equation – Equation of motion – Equations of state – Transport equations – Chemical Kinetics – Algebraic and Integral / differential equations, Explicit and Implicit equations –Numerical Integration,Feed forward and feed backward control.

Basic modeling for tank system, mixing vessel – Simultaneous mass and energy balances – Models for boiling, batch distillation, and partial condenser.

Models for Reactor – Model for heterogeneous catalysis – Models for pumping system – Model for heat exchanger.

Operational blocks in simulation- Simulation Programming – Simulation examples of three CSTR's in series, gravity flow tank, binary distillation column, non–isothermal CSTR.

Implicit function convergence ,Internal–halving convergence, Newton–Raphson method, False position convergence, Explicit convergence methods, Numerical Integration, Euler Integration, Runge - Kutta (fourth order) method.

Textbooks:

1. Process Modeling, Simulation and Control for Chemical Engineers by Luyben, W.L., McGraw Hill Books Co.

2. Mathematical Modeling in Chemical Engineering by Roger, G.E. Franks – John Wiley Sons Inc.

Reference Book:

Mathematical Methods in Chemical Engineering by V.G. Jenson and G.V. Jefferys, Academic Press – 2nd Edition.

MPE-2.1.2: Elective –VI (Open Elective)

MPE-2.1.2 A : Elective-VI (Nanotechnology)

Common for M.Tech (Chemical, MPE, CACE, IPCE, Biotechnology)

Objectives:

Nanotechnology may be treated as Green technology. It is one of the most advanced technologies now-a-days. It leads to have revolutionary changes in the fields of medical, Bio-medical, and fabrication of materials. Technologists are able to prepare ageless materials with the help of nano-techniques. Main objectives of the subject nanotechnology are :

1. To define green technology properly

2. To expose the students with new techniques of the nanotechnology.

3. To make them to learn the importance of quantum technology

4. To learn the procedure ageless materials to avoid wear-tear.

5. To learn the importance of nano –robots, machines

6. To know about the latest microscopes such as SEM, TEM

7. To know the importance of nanotechnology in the dawn of optical instruments

Outcome:

1. Application of nanotechnology in the development of energy

2. Application of nanotechnology in the development of solar panels, Fuel cells

3. Knew the importance of atoms manipulation

4. Knew that the applications of nanoparticles in the development of DVD, LEDs etc.

5. Biomedical applications in terms of preparing artificial, drug delivery, encapsulation, addition to that pharmaceuticals.

SYLLABUS

1. Introduction to nanotechnology, molecular and atomic size, surface and dimensional spaces. Molecular nanotechnology: atoms by inference, electron microscopes, nanomanipulator, nanotweezers, atom manipulation, nanodots, nanolithography.

Learning Outcomes:

* Define the term nanotechnology to understand in a better way the subject basics

* Demonstrate the different types of Electron Microscopes and their uses.

2. Nanopowders and nanomaterials: preparation, plasma arcing, chemical vapor deposition, sol-gels, electrodeposition, Ball milling, applications. Carbon nanotubes: types, formation, assemblies, purification, properties and uses.

Learning Outcomes:

* Summarize the nanomaterials used for the preparation of nanopowders

* Apply and selection of the different methods to prepare nanopowders

* Classify the carbon nanotubes and purification process.

3. Molecular mimics: Catenanes and rotaxanes, various molecular switches, synthesis of rotaxanes and catenanes, molecular computers, chemical rotors, prodders, flippers, atom shuttles, actuators, contacts.

Learning Outcomes:

* Categorize the molecular switches and synthesis of rotaxane and catenanes

* Examine the function of molecular computers

4. Nanobiometrics: Lipids as nano-bricks and mortar, self – assembled monolayers, proteins, 3-D structures arising from amines acids, nanoscale motors, Biological Computing, ion channels as sensors, Information in DNA structure, using DNA to build nano-cubes, hinges, smart glue, wire template.

Learning Outcomes:

* Evaluate the importance of nanobiometrics as self-assembled monolayers and nanoscale motors.

* Explain the process of biological computing and using DNA as hinges, smart glue, wire template

5. Optics, photomics and solar energy: Properties of light and nano technology, Interaction of light and nanotechnology, Nanoholes and photons, Imaging, New low cost energy efficient windows and solar absorbers based on nanoparticles, Photonic crystals, surface wave guides and control of light paths.

Learning Outcomes:

* Discuss about the optics, photomics and solar energy with reference to light properties.

* Chose a technique using nanoparticles to manufacture solar absorber, photonic crystals and change the light path.

6. Nanoelectrons: birth of electrons, semiconductors, transistor, integrated circuits, the tools of micro and nanofabrication, quantum electronic devices, quantum information and quantum computers, experimental implementations of quantum computers.

Learning Outcomes:

* Appraise different phased in the development of nanoelectornics tools.

* Construction of quantum computers and its experimental implementations.

7. Future applications: microelectomechanical systems, nano-robots , ageless materials, invisible mending of atomic dislocations inside damaged materials, nanomechanics and nanoelasticity, nanoparticle coatings, nanoelectronic and magnetic devices and new computing systems, optoelectronic devices, environmental applications.

Learning Outcomes:

* Assess the future application of nanotechnology in various fields

* Create new tools with nanotechnology to prepare new devices

Text-book:

1. M.Wilson, K.Kannangara, G. Smith, M. Simmons and B. Ragues, Nanotechnology, Overseas press (India) Private Ltd; New Delhi, 2005.

Reference books:

1. G. Ali Mansoori*, Principles of Nanotechnology, World Scientific Publishing Company, 2005.

2. G. Timp, Nanotechnology, Springer-Verlag, Network, 1999.

3. P. Poole and F.J. Owens, Introduction to Nanotechnology, John Wiley, 2003.

4. D.Ratner and M.Ratner, Nanotechnology: A Gentle Introduction, Pearson Education,2003.

5. B. Bhusan, Handbook of Nanotechnology, Springer, 2004

MPE-2.1.2 B: Elective-VI (POLLUTION CONTROL)

Common for M.Tech (Chemical, MPE, CACE, IPCE, Biotechnology)

Objectives:

* Focus on classification of air pollutants, water pollutants and solid waste –causes, effects and control methods, need of environmental Legislation.

Outcome:

* Enables the students to adopt the preventive measures for the control of air pollutants, waste water treatment methods, and solid waste management methods in domestic, municipal waste.

* Enables the students to understand the control measures of pollutants emitted from different industries like Paper and pulp, fertilizer, sugar and alcohol, petrochemical and petroleum refinery, pharmaceutical and metal finishing industries.

SYLLABUS

Kinds of ecology, environment and ecofactors, types of ecosystems, sulphur cycles, phosphorous cycle, Nitrogen cycle and hydrological cycle Sources for water, Air and solid pollution, Analysis and effects of the pollutants in air, in water, Solids(particulate matter, SOx, NOx, Cox, CHx). Limits of pollutants, Environmental Legislation.

Control aspects of various pollutants Air (Particulate matter, SOx, NOx, COx, CHx, Noise) water (primary, secondary and territory treatment techniques) Solids (recycling, incineration, bio-conversion).

Case studies of Industries: Paper and pulp, petrochemical, Fertilizer, Pharmaceuticals, tannery, sugar and alcohol industries, metal finishing industries.

Learning Outcomes:

* Describe different ecosystems
* Explains the bio-geochemical cycles
* classify the main types of pollution and their effects
* Describe the sources of pollution and their characteristics
* Describe the effects of air and water pollution on the environment and on human health
* Explain the importance of Environmental Legislation for pollution prevention and control
* Evaluate the preventive measures for the control of air pollutants – SPM
* Select the most appropriate technique to control SOx, NOx, COx, CHx
* Describe the primary, secondary and territory treatment techniques waste water treatment methods
* Propose control measures of pollutants emitted from different industries like paper and pulp
* Plan to select most appropriate technique to control pollutants from petrochemical and refineries
* Explain the control aspects of pollutants from Fertilizer, Pharmaceuticals
* Elucidate the control aspects of pollutants from tannery, sugar and alcohol industries, metal finishing industries

Text books:

1. S.P.Mahajan., Pollution control in process Industries, Tata McGraw hill publishing company.
2. Arcadio P. Sincero and Georgia Sincero., Environmental Engineering
3. Environmental Pollution Control., by C.S.Rao, wiely eastern ltd.

MPE-2.1.2 C: Elective-VI (Corrosion Engineering)

Common for M.Tech (Chemical, MPE, CACE, IPCE, Biotechnology)

Course Objectives:

* Basic aspects of electrochemistry relevant to corrosion phenomena,
* Importance and forms of corrosion.
* Knowledge on corrosion rate expressions and measurement techniques.
* Basic knowledge on remedial measures for corrosion.

Course Outcomes:

At the end of the course, the student will be able to

* Identify various forms of corrosion.
* Determine corrosion rates for metals from their polarization curves
* Analyze corrosion rate characteristics from electrochemical impedance spectroscopy
* Select suitable corrosion resistant coatings, oxide layers for various applications

SYLLABUS

Introduction and scope: Corrosion definition, wet and dry corrosion, mechanism, electro-chemical principles and aspects of corrosion, Faradays laws, resistance, specific resistance, conductance, specific conductance, transport numbers, ionic mobility, corrosion rate expressions, calculation of corrosion rates, thermodynamic aspects of corrosion, equilibrium potential, Nernst equation for electrode potential, EMF series, over voltage, application of Nernst equation to corrosion reactions,

Polarisation and corrosion potentials: References electrodes for corrosion measurements, types of polarisation, concentration, activation and resistance polarizations, Tafel constant, Evans diagrams, anodic control, cathodic control, mixed control, Pourbaix-diagram for Fe-H_2O system,

Various forms of corrosion: Uniform attack, galvanic corrosion, crevice corrosion, pitting corrosion, intergranular corrosion, selective leaching (dezincification), cavitation damage, fretting corrosion, erosion corrosion, and stress corrosion and remedial measures,

Prevention techniques: Modification of the material by alloying, appropriate heat treatment, chemical and mechanical methods of surface treatment, metallic, non-metallic linings, inhibitors, passivity, Cathodic protection and anodic protection.

TEXT BOOKS:

1. 'Corrosion Engineering' by Mars G. Fontana, Tata McGraw Hill Publishing Company, New Delhi
2. 'Corosion and Corrosion Control' by H.H.Uhllg, John Wiley & Sons Inc., America

REFERENCE BOOKS:

1. 'Electrochemistry' by Samuel Glasstone, Litton Educational Publishing Company
2. 'Electrochemistry, Principles & Applications' by Edmond C.Potter, Cleaver Hume Press Limited.

SCHEME OF INSTRUCTION & EXAMINATION

1/2 M.TECH (COMPUTER AIDED CHEMICAL ENGINEERING)
FIRST SEMESTER

(With Effect From 2021-22 Admitted Batch Onwards)

Under Choice Based Credit System

Code No.	Course	Credits	Theory	Tutorial	Lab	Total	Sessional marks	Exam marks	Total marks
CHEM 1.2.1	Computer aided design	3	3	1	—	4	30	70	100
CACE 1.1.1	Chemical Reaction Engineering	3	3	1	—	4	30	70	100
CACE 1.1.2	Transport phenomena	3	3	1	—	4	30	70	100
CACE 1.1.3	Elective-I	3	4	—	—	4	30	70	100
CACE1.1.4	Elective-II	3	4	—	—	4	30	70	100
CACE1.1.5	Research Methodology & IPR	2	4	—	—	4	30	70	100
CACE1.1.6	Audit Course–1*	0	2	-	—	2	—	—	—
CACE 1.1.7	Elective lab(MATLAB)	2	—	—	3	3	50	50**	100
CACE 1.1.8	Seminar	2	—	—	3	3	100	—	100
	TOTAL	18	20	2	6	28	300	400	700

*To be included as 'Qualified' or 'Not Qualified' in the marks list

**only internal evaluation

Elective-I: 1. Computational Fluid flow & Heat Transfer
2. Distillation Design & control
3. Process Flow sheeting

Elective-II: 1. Corrosion Engineering-I
2. Energy Engineering-I
3. Reaction Engineering-I

Audit Course 1 : 1. Yoga for working professionals
2. Organizational Behaviour

SCHEME OF INSTRUCTION & EXAMINATION

1/2 M.TECH (COMPUTER AIDED CHEMICAL ENGINEERING)
SECOND SEMESTER

(With Effect From 2021-22 Admitted Batch Onwards)

Under Choice Based Credit System

Code No.	Course	Credits	Theory	Tutorial	Lab	Total	Sessional marks	Exam marks	Total marks
CACE 1.2.1	Computer Aided Design	3	3	1	—	4	30	70	100
CACE1.2.2	Process Dynamic and Control	3	3	1	—	4	30	70	100
CACE 1.2.3	Separation Process	3	3	1	—	4	30	70	100
CACE 1.2.4	Elective-III	3	4	—	—	4	30	70	100
CACE1.2.5	Elective-IV	3	4	—	—	4	30	70	100
CACE1.2.6	Audit Course–2*	0	2	-	—	2	—	—	—
CACE 1.2.7	Elective lab(ASPEN PLUS)	2	—	—	3	3	50	50	100
CACE 1.2.8	Seminar	2	—	—	3	3	100	—	100
	TOTAL	19	19	3	6	28	300	400	700

*To be included as 'Qualified' or 'Not Qualified' in the marks list

Elective-III: 1. Computational Methods
2. Process optimization
3. Neural Networks

Elective-IV: 1. Corrosion Engineering-II
2. Energy Engineering-II
3. Reaction Engineering-II

Audit Course 2 : 1. Disaster Management
2. Entrepreneurship

SCHEME OF INSTRUCTION & EXAMINATION

2/2 M.TECH (COMPUTER AIDED CHEMICAL ENGINEERING)
FIRST SEMESTER

(With Effect From 2021-22 Admitted Batch Onwards)

Under Choice Based Credit System

Code No.	Course	Credits	Theory	Tutorial	Lab	Total	Sessional marks	Exam marks	Total marks
CACE 2.1.1	Elective-V	3	4	—	—	4	30	70	100

CACE2.1.2	Elective-VI(Open Elective)	3	4	—	—	4	30	70	100
CACE 2.1.3	Dissertation (preliminary)	9	—	—	—	—	100	—	100
	TOTAL	15	8	—	—	8	160	140	300

Note: The dissertation shall be evaluated through Viva-voce examination by a committee with HOD, Chairman, Board of Studies and Research guide as members. The marks shall be awarded in the ratio of 30,30 and 40 percent by the members Respectively

Elective-V: 1. Process Modelling and Simulation
2. Bioinformatics
3. Advanced Engineering Mathematics and Statistics

Elective-VI : 1. Nano Technology
(open elective) 2. Pollution Control
3. Corrosion Engineering

SCHEME OF INSTRUCTION & EXAMINATION

2/2 M.TECH (COMPUTER AIDED CHEMICAL ENGINEERING) SECOND SEMESTER

(With Effect From 2021-22 Admitted Batch Onwards)

Under Choice Based Credit System

Code No.	Course	Credits	Theory	Tutorial	Lab	Total	Sessional marks	Exam marks	Total marks
CACE 2.2.1	Dissertation	16	—	—	—	—	—	100	100
	TOTAL	16	—	—	—	—	—	100	100

Note: The dissertation shall be evaluated through Viva-voce examination by a committee with an external member nominated by University, HOD, Chairman, Board of Studies and Research guide as members. The marks shall be awarded in the ratio of 20, 20, 20 and 40 percent by the members respectively

SYLLABUS

M.TECH. I SEMESTER

CACE-1.1.1: Chemical Réaction Engineering

(Common for Chemical, MPE, CACE & IPCE)

Objectives:

* To focus on the thermal characteristics of various reactions and the design aspects of non isothermal and adiabatic reactors

* To focus on Heterogeneous data analysis and design

* To focus on CVD reactors

* To study the design aspects of heterogeneous catalytic systems

* To impart the knowledge on mass transfer with reaction in process catalysts

Outcome:

* Enables the students to understand the design aspects of non isothermal and adiabatic reactors

* Enables the students to on heterogeneous data analysis and design aspects of heterogeneous catalytic systems

* Able to derive the rate laws for CVD

* Able to develop the rate laws for heterogeneous fluid solid catalyzed reactions under rate limiting situations.

SYLLABUS

Review of Fundamentals Rate laws and stiochiometry, reactions with phase change (Scope: Chapter 3 of Fogler) Least squares Analysis of rate data: differential reactors: Laboratory reactors (Scope: sections 5.4 to 5.6 of Fogler) Multiple reactions (Scope: Chapter 9 of Fogler). Isothermal reactor design (Scope: Chapter 4 of Fogler) Batch reactor, PFR, CSTR design. Pressure drop in reactors, Reversible reactions, unsteady state operation of reactors, Simultaneous reaction and separation

Catalysis and catalytic reactors (Scope: Chapter 6 of Fogler) Steps in catalytic reaction: derivation of rate laws, design for gas-solid reactions, heterogeneous data analysis and design; Chemical vapour deposition, catalyst reactivation, moving bed reactions. Diffusion and reaction in process catalysts (Scope: Chapter 11 of Fogler). Diffusion and reaction in spherical catalyst.

Internal effectiveness factor, falsified kinetics; estimation of diffusion and reaction limited regimes. Mass transfer and reaction in packed bed. Determination of limiting situations from reaction data, CVD reactors.

Non-isothermal reactor design (Scope: Chapter 8 of Fogler), Energy Balance, equilibrium conversion under adiabatic conditions unsteady state operation, multiple steady states.

Learning outcomes:

* Express important concepts in reaction kinetics and classify reactions according to different properties.

* Calculate the reaction rate constant and reaction activation energy using Least squares Analysis of rate data

* Explain

* Explain the criteria used to evaluate the laboratory reactors and solve problems related to multiple reactions

* develop performance equations for different types of reactors using mass balances

* Design different reactors and explains the Simultaneous reaction and separation.

* Develop the rate laws for heterogeneous fluid solid catalyzed reactions under rate limiting situations.

* Develop the expression for concentration profile and effectiveness factor for first order reaction in a spherical pore of a catalyst.

* Explain different mechanisms postulated for adsorption and surface reaction in catalytic reactions.

* Explain the mass transfer and reaction in a packed bed.

* Do design calculations for non isothermal and adiabatic reactors

* Investigate the effect of temperature on reactor design and reaction parameters.

* Calculates the multiple steady states for MFR type reactors

Textbook:

Fogler. H.S: Elements for Chemical Reaction Engineering 2nd Edition, Prentice Hall, New Delhi, 1992.

Reference:

Smith J.M: 'Chemical Engineering Kinetics' 3rd Edition, McGraw Hill, 1981.

CACE -1.1.2: Transport Phenomena
(Common for Chemical, MPE, CACE & IPCE)

Objectives:

* To be able to analyze various transport processes with understanding of solution approximation methods and their limitations.

Outcomes:

* Ability to understand the chemical and physical transport processes and their mechanism.

* Ability to do heat, mass and momentum transfer analysis.

* Ability to analyze industrial problems along with relevant approximations and boundary conditions.

* Ability to develop steady and time dependent solutions along with their limitations.

SYLLABUS

Unit 1: Momentum Transport : 1.1 The Equations of change for isothermal systems. 1.2 Velocity distributions with more than one independent variable. 1.3 Velocity distributions in turbulent flow. 1.4 Inter phase transport in isothermal systems.

At the end of the course, the student will be able to:

* Perform momentum balance for a given system at microscopic scale.

* Solve the governing equations to obtain velocity profile.

* Solve the unsteady state momentum equation to obtain velocity profiles

* Understand the momentum transport under turbulent conditions and can be able to find out the friction factor or drag coefficient for a fluid flow system

Unit 2: Energy Transport : 1.1 The Equations of change for non – isothermal systems. 1.2 Temperature distributions with more than one independent variable. 1.3 Temperature distributions in turbulent flow 1.4 Inter phase transport in non isothermal systems.

At the end of the course, the student will be able to:

* Perform energy balance for a given system at microscopic scale.

* Solve the governing equations to obtain temperature profiles at steady state and unsteady state condition.

* Understand the energy transport under turbulent flow conditions and can be able to find out the heat transfer coefficient.

Unit 3: Mass Transport : 1.1 The Equations of Change for multi component systems. 1.2 Concentration distribution with more than one independent variable. 1.3 Concentration distribution in turbulent flow.

At the end of the course, the student will be able to:

* Perform the mass balance for a given system at microscopic scale and can be able to solve the governing equation to obtain concentration profiles.

* Solve the unsteady state mass balanceequation to obtain concentration profiles

* Understand the mass transport phenomena under turbulent flow conditions.

Textbook:

"Transport phenomena" R. Byron Bird, Warren E. Stewart and E.N. Light foot, Wiley & Sons, Inc., New York.

Reference Books:

1."Fundamentals of Momentum, Heat and Mass Transfer" James R. Welty, Charles E. Wicks and Robert E. Wilson, John Wiley & Sons, Inc., New York.

2. "Boundary – Layer Theory", Dr.H.Sehlichting, McGraw – Hill Book Company, New York.

CACE-1.1.3: Elective – I

CACE - 1.1.3 A - Elective-I
(Computational Fluid flow and Heat transfer)

OBJECTIVES

To introduce the students to widely used techniques in the numerical solution of heat transfer, and fluid flow equations, issues that arise in the solution of such equations, and modern trends in Computational Fluid Flow and Heat transfer (CFF & HT).

OUTCOMES

* To develop an understanding for major theories, approaches and methodologies used in Fluid Flow Dynamics

* To build up skills in the actual implementation of CFD methods (e.g. boundary conditions, different numerical schemes etc.)

* To gain experience in the application of CFD analysis to real life engineering designs.

Learning outcomes

The course provides an introduction to computational fluid dynamics. The students will train the numerical solution of model problems by developing and testing own MATLAB programs and using Aspen Plus Software. The students will learn to assess the quality of numerical results and the efficiency of numerical methods for basic fluid flow model problems.

Knowledge: After completion of this course, the student will have knowledge on:

* Classification of the basic equations of fluid dynamics.

* Basic space and time discretization methods.

* Numerical solution of advection, diffusion and stationary problems.

* Numerical solution of conservation laws.

* Analysis of accuracy and stability of finite difference methods for model equations.

Skills: After completion of this course, the student will have skills on:

* Practical use and programming of numerical methods in fluid dynamics.

* Checking and assessing the accuracy of numerical results.

* Assessing the efficiency of numerical methods.

* Consistency analysis and von Neumann stability analysis of finite difference methods.

* Choosing appropriate boundary conditions for model problems.

General competence: After completion of this course, the student will have general competence on:

* Numerical solution of model problems in fluid dynamics.

* Checking and assessing basic numerical methods for fluid flow problems.

Line Outcomes:

UNIT-I : 1. After completing this unit, the students will be able to classify partial differential equations and derive boundary layer equations for laminar and turbulent flows such as Crank-Nicolson and ADI methods to solve heat transfer problems. 2. In the second part of the unit, students study the external laminar flow by similarity and implicit finite difference methods.

UNIT-II 1. By studying this unit, students will be able to gain knowledge about Internal laminar flows 2. Students can solve problems related to fully developed flow and heat transfer for flow in a duct or channel and flow in a plane duct with a developing temperature field.

UNIT-III : 1. The students become familiar in turbulent flow: Governing equations - turbulence models - mixing length model - K-E (epsilon) model. 2. After completion of this unit students will have knowledge on External turbulent flow over a flat plate, to find solution by analogy between momentum and heat transfer and numerical solution of the boundary layer equations by finite difference method.

UNIT-IV : 1. Students will be able to find analogy solutions in Internal turbulent flow for fully developed pipe flow and Solution of laminar incompressible flow problems by vorticity-stream function formulation 2. Students can solve problems related to flow in a rectangular cavity - application to cylindrical coordinates - flow over a sphere.

UNIT-V : 1. Upon completion of this unit students will be able to gain knowledge in MAC and SIMPLE algorithms to solve Unsteady state Navier-Stokes equations for incompressible flows 2. Students will learn staggered Grid and MAC (Marker and Cell) method - implementation of boundary conditions, also solution of energy balance equation using SIMPLE formulation , upwind differencing - pressure correction - TDMA and Thomas algorithm.

Text Books:

1. Introduction to convection heat transfer analysis, Patrick H. Oosthuizen and David Naylor, McGraw-Hill Inc., New York (1999). (For topics 1 to 6)

2. Computational fluid flow and heat transfer, Second Edition, K. Muralidharan and T.Sundararajan (Editors), Narosa Publishing House, New Delhi (2003). (For topics 1, 7 and 8)

Reference Books:

1. An Introduction to computational fluid dynamics: The finite volume method, H.K. Versteeg, W. Malalasekra, Prentice Hall (1995).

2. Computational fluid dynamics – the basics with applications, John D. Anderson, Jr., McGraw-Hill International Editions, New York (1995)

CACE-1.1.3 B: DISTILLATION DESGIN & CONTROL

Syllabus

(Design and control of Distillation columns will be emphasized using ASPEN in this subject.)

1. Review of vapor-liquid equilibrium. Analysis of distillation columns: degrees of freedom, McCabe-Thiele method, approximate multicomponent methods, analysis of ternary systems.

2. Setting up a steady-state simulation: configuring a new simulation, specifying chemical components and physical properties, specifying stream properties and equipment parameters, running the simulation, finding the optimum tray and minimum conditions, column sizing.

3. Distillation economic optimization: heuristic optimization, economic basis, operating optimization.

4. Steady-state calculation for control structure selection: summary of methods, binary Propane/Isobutane system, ternary BTX system, multicomponent hydrocarbon system, ternary azeotropic system.

5. Converting from steady-state to dynamic simulation: equipment sizing, exporting to ASPEN dynamics, installing basic controllers, performance evaluation, comparison with economic optimum design.

6. Reactive Distillation: types reactive distillation systems, TAME process basics, TAME Reaction Kinetics and VLE, plant control structure.

7. Control of Petroleum Fractionators: petroleum fractions, characterization of crude oil, steady-state design of pipestill, control of pipestill.

Text book:

W.L. Luyben, Distillation Design and Control using Aspen Simulation, John Wiley,2006.

Reference books:

1. M.F. Doherty and M.F.Malone, Conceptual Design of Distillation Systems, Mcgraw-Hill, 2001.

2. P.B. Deshapande, Distillation Dynamics and Control, Instrumentation Systems Publishers, 1985.

3. H.Z. Kister, Distillation Design, Mcgraw-Hill, 1992.

4. M. Van Winkle, Distillation , Mcgraw-Hill, 1967.

CACE-1.1.3 C: PROCESS FLOWSHEETING

SYLLABUS

1. Steady state and dynamic flow sheeting and the design process, the total design project, Flow sheeting on the computer: motivation for the development, developing a simulation model, approaches to flow sheeting systems

2. Solving linear and nonlinear algebraic equations: solving one equation in one unknown, solution methods for linear equations, general approaches to solving sets of nonlinear equations, sloving sets of sparse nonlinear equations

3. Physical property service facilities: The data cycle, computerized physical property systems, physical property calculations; Degrees of freedom in a flow sheet: degrees of freedom, independent stream variables, degrees of freedom for a unit, degrees of freedom for a flowsheet

4. The sequential modular approach to flowsheeting: The solution of an example flowsheeting problem, other features, convergence of tear variables. Partitioning and tearing of a flowsheet.

5. Flowsheeting by equation solving methods based on tearing

6. Simulation by linear methods

7. Simulation by quasi linear methods

Text book:

A.W. Westerberg, H.P. Hutchison, R.L. Motard, and P. Winter , Process Flowsheeting, Cambridge University press, 1979

Reference books:

1. Leesley, M.E., Computer aided process plant design, Gulf Publishing, Huston, 1982

2. R.Turton, R.C.Bailie, W.B.Whiting and J.A.Shaeiwitz, Analysis, Synthesis and Design of Chemcal Processes, Prentice Hall, 1998.

3. W. D. Seider, J.D. Seader, and D.RLewin, Product and Process Design Principles: Synthesis, Analysis and Evaluation, 2nd edition, 2003, John Wiley & Sons(Asia) Pte. Ltd.

CACE-1.1.4: Elective –II

CACE -1.1.4 A - Elective-II (Corrosion Engineering-I)

Common for M.Tech (Chemical, MPE, IPCE, CACE & Biotechnology)

Objectives : The main objectives are to provide:

1. Basic aspects of electrochemistry relevant to corrosion phenomena,

2. Importance and forms of corrosion.

3. Knowledge on corrosion rate expressions and measurement techniques.

4. Knowledge on factors influencing corrosion of iron and steel exposed to atmospheric, soil and aqueous medium.

5. Basic knowledge on remedial measures for corrosion.

Outcome: At the end of the course, the student will be able to

1. Acquires knowledge on basic principles of electrochemistry, importance of corrosion.

2. Predict whether corrosion will occur for a particular environment.
3. Estimate corrosion rates and analyze.
4. Identify the type of corrosion and propose viable remedial measures.

SYLLABUS

Basic Concepts and Outlines of Electrochemistry: Fundamentals of Electrochemical reactions, Faraday's Laws Electrolytic and ionic conductance, ionic mobility's, Transport Nos. Galvanic Cell and Electrolytic cells.

Definition and importance of corrosion, Dry cell, analogy, Corrosion Cells, Types of Corrosion Cells- a) Dissimilar electrode cells b) Concentration cells such as a salt concentration cells, differential aeration cells c) differential Temperature cells. Corrosion Rate Expresions - mdd, ipy, cpy, mpy, etc.

LO1: Choose a specific cell for a given situation

LO2: Identify the type of corrosion cell that will form in that particular environment

Corrosion Tendency and Electrode Potentials: Free Energy changes, Development of Nernst Equation for calculation of Half-cell potentials, Hydrogen electrode, Spontaneity of a reaction, Reversible cells and potentials – convention of Sign and calculations of EMF from standard Equilibrium potentials., EMF Series and Galvanic series, Reference Half Cells – Calomel, Silver-Silver Chloride and Saturated Copper-Copper Sulphate Half Cells. Pourbaix Diagram for Iron, Aluminum and magnesium, limitations of pourbaix diagrams.

LO3: Predict the tendency of corrosion to occur

LO4: Identify the corrosion zones based on pH of media

Polarization and Corrosion Rates: Polarization and a Polarized Cell, Causes of Polarization – Concentration Polarization, Activation Polarization and IR drop. Hydrogen Over potentials, combined polarization and Mixed potential theory. Tafel Slopes and Tafel Equation. Graphical method of expressing Corrosion Reactions (Polarization diagrams/Evans diagrams), Derivation of Stern-Geary Equation, Influence of Polarization on Corrosion rates.

LO5: Derive the equations for estimating corrosion rates

LO6: Evaluate and Analyze data for corrosion rates

Passivity: Characteristics of Passivation, Flade potential, behavior of passivators, transpasivity, Theories on Passivity.

Forms of Corrosion: Uniform attack, Galvanic Corrosion, Crevice Corrosion, Pitting, Intergranular Corrosion, Selective Leaching, Erosion Corrosion and Stress Corrosion. Hydrogen damage. Factors influencing, mechanisms and prevention techniques for all forms of corrosion. Calculation of Corrosion rates using weight lost method and Polarization data. Electrochemical Impedance Spectroscopy.

Effect of Dissolved Oxygen (Air saturated Water, High Partial Pressure of Oxygen and Anaerobic bacteria), Temperature, pH, Galvanic coupling, velocity, dissolved salts concentration. Wet and dry corrosion.

LO7: Identify the type of corrosion

LO8: Recommend proper remedial measures

Textbooks :

1. Corrosion and Corrosion Control by Herbert, H. Uhlig John Wiley and Sons Inc., New York.

2. Corrosion Engineering by Mars F Fontana, McGraw Hill.

3. An Introduction to Electrochemistry by Samuel Glass stone, Affiliated East West Press Pvt. Ltd.,

Reference Books :

1. Corrrosion Volumes 1 & 2 by L.L. Shrier, Newnes - Butter-worths, London.

CACE - 1.1.4 B - Elective-II (Energy Engineering-I)

Common for M.Tech (Chemical, MPE, IPCE, CACE & Biotechnology)

Objectives:

To lean overview of solar radiation and it's potential for collection to meet the energy needs of mankind and potential for solar energy option. To learn measuring techniques of solar radiation and its compilation.

To learn various design and operational aspects of solar energy collection and storage.

To learn the design and operation of solar energy appliances like liquid flat plate collectors, Solar Air Heaters, Thermal energy storage, Thermal energy storage, Solar Pond, Solar thermal power generation.

To learn theory and application of Photovoltaic cells

Outcome:

The student learns collection and design of various kinds of equipment operated on solar energy. The student learns principles and practice of Photo voltaic cells.

SYLLABUS

The Solar Energy option

Thermal conversion – collection and storage Thermal applications – photovoltaic conversion – wind energy – Energy from Bio – mass – ocean thermal energy conversion.

Solar Radiation

Solar Radiation outside the earths – atmosphere Solar radiation at the Earth's surface – Instruments for measuring Solar Radiation – Solar Radiation data – Solar Radiation Geometry Empirical equations for predicting the availability of Solar Radiation – Solar radiation on tilted surface.

Liquid flat – Plate Collectors

Components of liquid flat plate – various types of collectors – Performance Analysis – Transmissivity – Absorptivity product – Overall loss coefficients and heat Transfer correlations – Collector efficiency heat removal factors – effect of various parameters on performance. Transient Analysis – Testing procedures.

Solar Air Heaters

Various types of solar Heaters – Performance Analysis of a conventional Air Heater – Testing procedures – Concentrating collectors – various types of concentrating collectors cylindrical and parabolic collectors – General receiver collectors.

Thermal energy storage

Sensible heat storage – Latent heat storage – Thermochemical storage

Solar Pond

Description – Performance analysis – Experimental studies – Operational problems.

Solar Air Conditioning and Refrigeration

Heat pump cycle – Coefficient of performance of the heat pumps – solar air-conditioning with absorption – Refrigeration system (Ammonia water and lithium bromide – water systems).

Solar thermal power generation

Thermal and direct electricity generation – Major sub-stations of a solar thermal power plant, Examples of installed systems – Concentration ratio. Temperature and efficiency concepts – Solar farm and tower – Economics.

Photovoltaic Energy Conversion

Photovoltaic Energy Conversion Fundamentals – band theory of solids – Physical processes in a solar cell – Solar cell with light incidence – Solar cell module – Silicon Solar Cells – Copper Sulphate / Cadmium sulphide Solar Cells.(Banasal et at.,chapters 9;Taylor, chapters 6, pages 256-298.

Text Books:

1. Solar Energy: Principles of thermal collection and storage by S.P. Sukhatme, Tata McGraw Hill, New Delhi 1984 (Chapters 2 to 8)

2. Renewable energy sources and conversion technology by N. K. Bansal, M. Kleemann, Michael Mcliss, 1990 (Chapters 2 – 9).

CACE - 1.1.4 C - Elective-II (Reaction Engineering-I)

Common for M.Tech (Chemical, MPE, IPCE, CACE & Biotechnology)

Unit I : (Scope : J.M. Smith : Chapter 7): Heterogeneous Processes, catalysis, and absorption: Global Rates of Reaction - Types of Heterogeneous Reactions - The nature of catalytic Reactions - The Mechanism of catalytic Reactions - Surface Chemistry and Absorption - Absorption Isotherms - Rates of Absorption.

Unit II (Scope : J. M. Smith: Chapter 8 : Solid Catalysts: Determination of surface area - Void Volume and solid density - Fore volume distribution - Theories of Heterogeneous Catalysis - Classification of catalysts - Catalyst Preparation - Promoters and Inhibitors Catalyst Deactivation (Poisoning).

Unit III: (Scope: J.M. Smith : Chapter 9): Rate equations for fluid - Solid Catalytic Reactions: Rates of adsorption, Desorption, Surface Reaction - Rate equations in terms of Fluid phase concentrations at the catalyst surface - Qualitative analysis of rate equation - Quantitative inter pretation of Kinetic data - Redox Rate equations.

Unit IV: (Scope : Octave Levenspiel : Chapter 15) : Deactivating Catalysts : Mechanism of Catalyst Deactivation - The ratre of equation - The rate of equation from experiment - Batch - solids: Determining the rate for Independent Deactivation Batch - solids : Determining the rate of parellel, series or side - by - side Deactivation - Flowing solids experimental Reactors - Finding the Mechanism of Decay from experiment Design.

Unit V: (Scope : J. M. Smith : Chapter 10) : External transport Processes in Heterogeneous Reactions: Fixed bed reactors - The effect of physical processes on observed rate of reaction - Mass and Heat transfer coefficients (fluid particle) in packed beds - Quantitative treatment of external transport effects - Stable operating conditions - Effect of external transport Processes on selectivity.

Fluidised bed reactors - Particle - fluid Mass and Heat transfer Slurry Reactors - Mass transfer coefficients: Gas bubble to liquid (K_1) - Mass transfer coefficients: Liquid to particle (K_c) - The effect of mass - transfer on observed rates Trickle - Bed reactors - mass transfer coefficients: Gas to liquid ($K_1 a_g$) - Liquid to particle ($k_c a_c$) - Calculation of global rate.

Text Books:

1. Smith. J.M., " Chemical Engineering Kinetics", McGraw Hill book Company, New Delhi (Third Edition) 1981.

2. Octave Levenspiel, " Chemical Reaction Engineering" , Wiley Eastern Limited - Second Edition - 1972.

Reference Books :

1. Thomas, J.M. And Thomas, W.J. " Introduction to the Principles of Heterogeneous Catalysis". Academic Press Inc., New York 1967.

2. Carbnerry, James, J., " Chemical and Catalytjic Reaction - Engineering", McGraw - Hill, Engineering Series.

CACE 1.1.5: RESEARCH METHODOLOGY AND IPR

Common for M.Tech (Chemical, MPE, IPCE, CACE & Biotechnology)

Unit 1: Meaning of research problem, Sources of research problem, Criteria Characteristics of a good research problem, Errors in selecting a research problem, Scope and objectives of research problem. Approaches of investigation of solutions for research problem, data collection, analysis, interpretation, Necessary instrumentations

Unit 2: Effective literature studies approaches, analysis, Plagiarism, Research ethics,

Unit 3: Effective technical writing, how to write report, Paper, Developing a Research Proposal, Format of research proposal, a presentation and assessment by a review committee

Unit 4: Nature of Intellectual Property: Patents, Designs, Trade and Copyright. Process of Patenting and Development: technological research, innovation, patenting, development. International Scenario: International cooperation on Intellectual Property. Procedure for grants of patents, Patenting under PCT.

Unit 5: Patent Rights: Scope of Patent Rights. Licensing and transfer of technology. Patent information and databases. Geographical Indications.

Unit 6: New Developments in IPR: Administration of Patent System. New developments in IPR; IPR of Biological Systems, Computer Software etc. Traditional knowledge Case Studies, IPR and IITs.

References:

1. Stuart Melville and Wayne Goddard, "Research methodology: an introduction for science

2. & engineering students'"

3. Wayne Goddard and Stuart Melville, "Research Methodology: An Introduction"

4. Ranjit Kumar, 2nd Edition , "Research Methodology: A Step by Step Guide for beginners"

5. Halbert, "Resisting Intellectual Property", Taylor & Francis Ltd ,2007.

6. Mayall , "Industrial Design", McGraw Hill, 1992.

7. Niebel , "Product Design", McGraw Hill, 1974.

8. Asimov , "Introduction to Design", Prentice Hall, 1962.

9. Robert P. Merges, Peter S. Menell, Mark A. Lemley, " Intellectual Property in New

10. Technological Age", 2016.

11. T. Ramappa, "Intellectual Property Rights Under WTO", S. Chand, 2008

CACE 1.1.6 A: Audit Course-1 (YOGA FOR WORKING PROFESSIONALS)

Common for M.Tech (Chemical, MPE, IPCE, CACE & Biotechnology)

Course objectives:

1. To make the student understand various practices of yoga and yoga diet.
2. To make the student be familiar with various asanas and other associated practices.
3. To make the student appraise the holistic benefits of yoga
4. To make the student identify a therapeutic solution for common health issues.
5. To make the student experience the pranahuti aided meditation.

Course outcomes:

1. The students will discover the importance of yoga for leading a disciplined way of life.
2. The students would improve their wellness by adapting various yogic practices in their day to day life.
3. The students would perceive the holistic benefits of yoga
4. The students can judge the causes of common diseases and can recommend therapeutic solutions based on yogic practices
5. The student can compare the placebo meditation and meditation with pranhuti.

Unit-I: Introduction to Yoga : The Origins of Yoga – Definitions - Concepts - Aims and objectives of Yoga - Yoga is a Science and Art - Ideal Practice of Yoga in the new millennium. Streams of Yoga - Karma Yoga - Bhakti Yoga - Jnana Yoga - Raja Yoga (Astanga Yoga) - Hatha Yoga - Yoga and Diet - - Yoga Disciplined way of life. Difference between Yogasanas and Physical Exercises.

Learning outcomes: 1. After completing this unit, the students will be able to recognize the differences between yogic practices and physical exercises. 2. At the end of this unit, the students will be able assess the relevance of yogic practices for holistic wellness in the contemporary times.

Unit-II: Yogasanas with practical : Loosening the joints- Joint freeing series, Suryanamaskar, Tadasana, Trikonasana, Artha chandrasana, Danurasana, Utkatasana, Dandasana, Pavanamuktasana, Hamsasana, Arthakati chakrasana, Artha chakrasana, Janusirasasana, Vajrasana,

Makarasana, Padmasana, Sukhasana, Natrajasana, Savasana. Introduction to Kriyas, Pranayamas, Bandhas and Mudras.

Learning outcomes:

1. The students will be able to demonstrate some selective yogasanas.

2. The students will be able to appraise the importance of allied yogic practices such as pranayama, mudras, bandhas and kriyas.

Unit-III: Physiological benefits of Yoga : Physiological Benefits of Asanas and Pranayama – Chest Cage – Regulation of Breathing – Types of Breathing. Physiological Benefits of Bandhas – Mudras – Kriyas - Meditation – Nadis – Chakras – Kundalini shakti – Psycho-neuro Immunology. Role of Yoga on Psychological Qualities and Psychological Disorders.

Learning outcomes:

1. By studying this unit, the students will be able to value the physiological benefits of yoga practices.

2. The students will be able to support the role of yoga in the treatment of psychological disorders at the end of this chapter.

Unit-IV: Introduction to Yoga Therapy : Essence and Principles of Yoga therapy- Physiology and Pathology in the yoga – Shatra- koshas – doshas- Granthis – Pancha prana – Application of Yoga and its types- Methodology in Yoga Therapy – Factors (Heyam, Hetu, Hanam and Upayam) - Methods (Darsanam, Sparsanam, Prasnam, Nadi, Pariksa) Examination of Vertebra, joints, Muscles, Abdomen and Nervous system and therapeutic applications – Modification of yogic practices for Human Systems- Yogic diet.

Learning outcomes:

1. At the end of the unit, the students become familiar in assessing the health of an individual.

2. After completing this unit, the students can recommend appropriate yoga therapy for health problems faced by an individual.

Unit-V: Meditation : (The student has to maintain a diary to record his observations during meditation. This diary will help him to understand the extent of his progress)

Meaning and Concept of Meditation – Need of meditation- techniques of meditation-Tools of meditation-Advantages of Meditation- Experience of meditation- Obstacles. Sahaj Marg Meditation, Heartfulness movement. Elements of sahaj marg meditation: Prayer, cleaning, sitting, satsang, universal prayer and suggestions. Ten maxims of sahaj marg.

Learning outcomes:

1. The student will be well versed in the benefits of meditation at the end of the unit.

2. The student can experience the difference in normal situation and meditative condition after experiencing pranahuti aided meditation.

Reference books

1. George Feuerstein: The Yoga Tradition (Its history, literature, philosophy and practice).

2. Georg Feuerstein. The Psychology of Yoga: Integrating Eastern and Western Approaches for Understanding the Mind.

3. Swamy Satyananda Saraswathi: Asana, Pranayama, Mudra, Bandha (India: Yoga Publications Trust, Munger, Bihar).

4. Swami Sivananda : Practice of Yoga (The Divine Life Society, Shivananda Nagar.P.O.,U.P. Himalayas, India).

5. Krishna Raman: A Matter of Health (Integration of Yoga and western medicine for prevention and cure) (Chennai East West Books(Madras) Pvt. Ltd.,1998.

6. Bhavanani, A.B. (2011): Application of Yoga Concept in the Health Improvement. In: P.Nikic, ed.

7. Ram Chandra, Complete works or Ram Chandra (Babuji) Vol. I, Sri Ram Chandra Misssion, SPHT, Calcutta.

CHEM CACE B- Audit Course -I Organizational Behavior

Common for M.Tech (Chemical, MPE, IPCE, CACE & Biotechnology)

UNIT-I: Organizational Behavior: Concept of Organization - Concept of Organizational Behavior - Nature of Organizational Behavior - Role of Organizational behavior - Disciplines contributing to Organizational Behavior.

UNIT-II: Motivation: Definition - Nature of Motivation - Role of Motivation - Theories of Motivation: Maslow's Need Hierarchy Theory, Herzberg's Motivation Hygiene Theory and McGregor's Theory X and Theory Y.

UNIT –III: Group Dynamics: Meaning - Concept of Group - Types of groups -Formal and Informal groups - Group development - Group cohesiveness and factors affecting group cohesiveness.

UNIT-IV: Leadership: Concept of Leadership - Difference between Leadership and Management - Importance of Leadership - Leadership styles: Autocratic leadership, Participative leadership and Free Rein leadership.

UNIT-V: Communication: Meaning - Communication Process - Forms of communication: Oral, Written and Non- Verbal communication - Direction of communication: Downward, Upward and Horizontal communication.

UNIT-VI: Organizational conflicts: Concept of conflict - Reasons for conflict - Types of Conflict: Intrapersonal conflict, Interpersonal conflict, Intragroup conflict, Intergroup conflict, Inter organizational conflict - Conflict management.

UNIT –VII: Organizational Change: Nature - Factors in Organizational change -Planned change: Process of planned change - Resistance to change: Factors in resistance to change - Overcoming resistance to change.

Text Books.

1. L.M.Prasad: Organizational Behavior, Sultan Chand & Sons, New Delhi -110002

2.K. Aswathappa: Organizational Behavior, Himalaya Publishing House, New Delhi

Reference Books.

1. Stephen Robbins: Organizational Behavior, Pearsons Education, New Delhi.

II SEMESTER

CACE –1.2.1: COMPUTER AIDED DESIGN

(Common for Chemical Engineering & CACE)

The objectives of this course are to provide the student with:

* a basic understanding of the fundamentals of executive program, executive program aided simulation, unit computations, information flow diagram, encoding of information flow diagram, simulation of a simple plant, applications of simulation

* knowledge to write algorithm and programs for various fluid flow problems, pressure drop in two phase flow, pipeline network calculations

* knowledge to write algorithm and programs for rating and design calculations heat exchanger, condenser, reboiler, flash calculations, distillation column, gas absorption column, crosscurrent and counter current extraction, analysis of data in a reactor, extent of reaction, ideal reactors, semibatch reactor, packed bed reactor and fluidized bed reactor

Outcome:

* Enables students to learn the basics of computer aided design, executive program aided simulation and its applications

* Students will be able to write/develop unit computations (programs) for fluid flow, mass transfer, heat transfer and reaction engineering problems

SYLLABUS

Unit I : Introduction on simulation and importance of simulation for chemical process industries Introduction to computer aided design- executive program. coding of chemical process flow chart. Information flow diagram, unit computations, developing a description of information flow diagram, information flow diagram to numerical form, planning calculations, finding recycles, planning calculations for recycle set.

Unit II : Mass transfer operations: introduction, distillation- simple binary distillation, Multicomponent flash calculations, multi component stage wise calculations, Gas absorption- absorption and stripping in plate columns, absorption in packed columns, Liquid extraction- single stage contact, cross current extraction, counter current extraction

Unit III : Flow of fluids in pipes: Introduction, flow of Newtonian fluid in a pipe- incompressible fluid flow, sizing of pipes, Pressure drop in compressible fluid flow, flow of non Newtonian fluids- Bingham plastic fluid, Power law fluid, generalized Reynolds number, Sizing of pipes for non Newtonian fluid How, Pipe network calculations, two phase flow systems- gas liquid flow, solid liquid flow, gas solid flow.

Unit IV : Heat transfer: Introduction, shell and tube exchangers without phase change- tube side heat transfer coefficients, shell side heat transfer coefficients, pressure drop in shell and tube heat exchanger, condensers, reboilers

Unit V : Chemical reaction Engineering: Introduction, extent of reaction, chemical reaction equilibrium- independence of reactions, calculation of chemical equilibrium, Analysis of rate data - Integral method, differential method, nonelementary reactions, temperature dependence of rate constant, Ideal reactors- batch reactor, continuous stirred tank reactor, plug flow reactor, semi batch reactor, Temperature effects in homogeneous reactors- ideal batch reactor, CSTR, PFR, Heterogeneous system- analysis of rate data, fixed bed reactor, catalyst deactivation.

Prescribed book:

1. Chemical Process calculations by Raghu Raman, Elsevier applied science publishers, London-New York

2, Simulation of sulphuric acid plant by Crowe

3. Product and process design principles- synthesis, analysis and evaluation by Warren Sieder, J.D. Sieder, Daniel R. Lewin

CACE-1.2.2: Process Dynamics & Control

(Common for MPE, CACE & IPCE)

Objectives :

The main purpose of teaching Process Dynamics & Control for first year postgraduate students is to take the student from basic mathematics to a variety of design applications in a clear, concise manner. This course is focused on the use of the digital computer in complex problem solving and in process control instrumentation. For chemical engineering problem solving students need more advanced mathematical preparation like partial differential equations, linear algebra and Fourier series all are introduced in this course.

Outcome:

* Able to know the sampled data control systems consists of sampling and advanced mathematical model Z- transforms.

* Able to describe the process in which the flow of the signals is interrupted periodically like in chromatograph.

* Able to calculate the open loop response of a sampled data system and can develop a pulse transfer function that is the counterpart of the transfer function for continuous systems.

* Able to know the sophisticated instruments used for the analysis of water and air pollutants, The student should have knowledge to design the equipment used for the abatement of these pollutants.

* In a position to modernize the solid waste management and the student must be in a position to get awareness on accidents that are occurring in industries during handling, storage, and manufacturing of chemicals, remedial measures to arrest the accidents immediately.

SYLLABUS

Unit-1 : Review of time domain, Laplace domain and frequency domain dynamics of process and control system.

Learning outcomes

* Able to know the sampled data control systems consists of sampling and

* Able to solve the problems related to Laplace domain and frequency domain dynamics of process and control system.

Unit-2 : Sampled data control system – sampling and Z–Transforms , open loop and closed loop response, Stability.

Learning outcomes

* Able to solve the problems related toSampled data control system – sampling and Z–Transforms ,

* Able to calculate the open loop response of a sampled data system and stability

Unit-3 : State space methods – representation of physical systems – transfer function matrix – Multivariable systems – Analysis and control.

Learning outcomes

* Able to solve the problems related toState space methods – representation of physical systems and Student can develop a pulse transfer function that is the counterpart of the transfer function for continuous systems.

* Able to solve the Design Multivariable control systems – Analysis and control.The student should have knowledge to design the equipment used for the abatement of these process control systems.

Unit-4 : Non linear control –examples of non linear systems – Methods of phase plane analysis.

Learning outcomes

* Able to solve the problems related toNon linear control systems

* Able to solve the problems related toexamples of non linear systems and also develops Methods of phase plane analysis.

Unit-5 : Control of heat exchangers, distillation columns and Chemical Reactors.

Learning outcomes

* Able to solve the problems related toControl of heat exchangers, distillation columns and

* Able to solve the problems related toChemical Reactors.

Textbooks:

1. Process system Analysis and control, 2nd edition, Donald R Coughanower and Koppel.

2. Automatic process Control by Peter Harriot.

3. Process Modeling, Simulation and control for Chemical Engineers by W.L. Luyben.

CACE – 1.2.3- SEPARATION PROCESSES

OBJECTIVES:

* To enable the physical and thermodynamic principles of mass transfer with an emphasis on how these principles affect the design of equipment and result in specific requirements for quality and capacity.

* To enable the students to know the design of a distillation column, design of a absorber and calculations involved in liquid liquid extraction.

* To enable the Model and solve problems related to flash distillation, liquid-liquid extraction, batch distillation, cascades, simple and complex binary distillation systems and absorption in packed towers

* To enable the Types and characteristics of membranes. Separation of gases. Separation of liquids. Osmosis. Reverse osmosis. Dialysis, Electro-dialysis. Pervaporation. Ultra filtration. Industrial applications

OUTCOMES:

* The student would know Design of design absorber and stripper, distillation column and extraction and the student would build and develop quantitative models of how these separation processes work and how to apply these in new applications

* The student would understand equilibrium and rate governed multistage separation processes and also characterization of membranes and separation processes such as reverse osmosis, dialysis, ultra filtration and electro dialysis.

SYLLABUS

Unit: -I : Introduction: Classification of reparation processes; Equilibrium – Based reparations General properties operation and complexities of reparations that involve mass rap rating agents and energy repeating agents. Review of vapor liquid and energy separating agents. Review of vapor liquid equilibrium and other equilibrium. Thermodynamic consistency test for VLE date phase rule and degrees of freedom estimations. Eqmilirinor ratio concept and its estimation from Defroster's charts; Bubble and Dew-Point calculations, Flash calculation estimation of state of the mixture.

* Able to know about degrees of freedom.

* Able to know about Bubble and Dew-Point calculations.

Unit-II : Binary separation process: Common approach for process design estimation of feed location, product qualities and theoretical stages of equilibrium based reparations: single stage-single component and Multistage single component reparation processes involving absorption stripping liquid -liquid immiscible extraction adsorption and distillation Kermes-brown equation and its limitation process designee (estimation of feed location, product qualities and theoretical stages) of multistage multiple feeds and side stream process.

* Able to understand the feed stage location in tray towers (Absorption and distillation).

* Able to understand the calculation of number of stages required for desired degree of separation using different methods.

Unit III : Multi component separation process: Multi component Distillation Introduction. Key components; Estimation of minimum theoretical stages (Fizzles equation0 Distribution as non-key components in airhead and bottom products at total refuse; Determination of minimum refuse ratio (under wood's method), Approximate calculation for multi component, multistage distillation estimation of actual refuse ratio and theoretical stages) kirks-Bridge equation) distribution of no-key components at actual refuse.

* Able to understand the selection of key components.

* Able to know Estimation of minimum number of theoretical stages.

Unit-IV : Capacity and efficiency of contacting devices energy requirements of seperation process case studies in the selection of separation process.

* Able to understand the Capacity and efficiency of contacting devices energy requirements.

Unit –V : Membrane separation process principled, characteristics and clarification of membrane reparation process, membrane materials, structure preparation of techniques, membrane modules, Membrane characterization pose size, pore distribution. Factors affecting retentively, Concentration polarization, gel polarization, fouling, eleaqing and refrigeration of membranes. Mechanisms of separation processes membrane, deme membranes and liquid membranes science and Technology of micro filtration reverse osmosis ultra filtration, Nan filtration dialysis and electro dialysis perspiration, liquid membrane permeation, gas permeation membrane reactor: polymeric, ceramic metal and Bio membranes.

* Able to understand the principles of Membrane separation process.

* Able to know about Technology of micro filtration, reverse osmosis, ultra filtration, dialysis and electro dialysis.

Textbook:

Separation Process Principles, 2nd Edition

J. D. Seader, Ernest J. Henley, John Willey & Sons, 2nd Edition 2006.

TEXT / REFERENCE BOOKS:

1. R.E. Treybal, Mass Transfer operation, 3rd edition MC Graw – Hill 1980

2. G.J. Geankoplis, Transport Process and separation process Principles, 4th equation, pretice Hall of India, 2007

3. P.H. Mankat, Equilibrum Stays Separation, Elsewies publication, 1988.

CACE-1.2.4 - Elective-III

CACE-1.2.4 A. ELECTIVE –III (COMPUTATIONAL METHODS)

OBJECTIVES

This course aims to develop a practical approach to Chemical Engineering problems solving using Numerical Methods. The course will introduce to many commonly used tools and techniques in numerical work. Due emphasis will be placed on converting algorithms and techniques to working computer codes. Carefully designed examples will help in understanding the nuances of the numerical techniques and computer applications of the same.

1. To provide suitable and effective methods called Numerical Methods, for obtaining approximate representative numerical results of the problems.

2. To solve problems in the field of Applied Mathematics, Theoretical Physics and Engineering which requires computing of numerical results using certain raw data.

3. To solve complex mathematical problems using only simple arithmetic operations. The approach involves formulation of mathematical models of physical situations that can be solved with arithmetic operations.

4. To deal with various topics like finding roots of equations, solving systems of linear algebraic equations, interpolation and regression analysis, numerical integration & differentiation, solution of differential equation, boundary value problems, solution of matrix problems.

5. To facilitate numerical computing using MATLAB and ASPEN PLUS

OUTCOMES

On completion of the course students will be able to

1. Apply Numerical analysis which has enormous application in the field of Science and some fields of Engineering.

2. Familiar with finite precision computation.

3. Familiar with numerical solutions of nonlinear equations in a single variable.

4. Familiar with numerical integration and differentiation, numerical solution of ordinary differential equations.

5. Familiar with calculation and interpretation of errors in numerical method.

6. Familiar with programming with packages like MATLAB and ASPEN PLUS

Learning outcomes

The course provides an introduction to computational fluid dynamics. The students will train the numerical solution of model problems by developing and testing own MATLAB programs and using Aspen Plus Software.

LINE OUTCOMES

UNIT-I : 1. By the end of this unit, students will be able to solve a system of linear equations using matrix inversions, factorization, norm and rank 2. Students will be able to solve a system of nonlinear equations using iterative methods, methods of Newton, Secant, Bracketing and Bisection, Newton's methods for multiple non-linear equations, Jacobian, Quasi-Newton methods.

UNIT-II : 1. By studying this unit, the students will be able to learn Orthogonal matrices, eigen values and vectors of real matrix, eigen values and properties of linear systems, estimating eigen values, eigen vector matrix decomposition and basis sets. 2. Students gain knowledge on numerical calculation eigen values and vectors, extremal eigen values, QR method, Single Values Decomposition, eigen problems in quantum mechanics, computing the roots of polynomial.

UNIT-III : 1. After studying this unit students will be able to solve Initial Value Problems (IVP) of ordinary differential equations, polynomial interpolation, Newton Cotes integration, Gaussian quadrature, multi-dimensional integrals 2. Students also learn dynamic stability, accuracy and stability of single step methods, stiff stability of BDF methods, simplistic methods for classical mechanics, differential-algebraic equation systems, parametric continuation.

UNIT-IV : 1. The students become familiar in BVPs from conservation principles, real space versus function space methods. 2. Students gain knowledge in finite difference methods for 2-D BVP, extension of finite difference method, chemical reaction and diffusion in spherical catalysts pillet.

UNIT-V : 1. After this unit students learn about conversion/diffusion equation, modeling a tubular reactor with dispersion, numerical issues for discretized PDEs with more than tow spatial dimensions. 2. Students gain knowledge on finite differences in complex geometries, finite volume method, finite element method (FVM).

Text book:

K.J.Beers, Numerical Methods for Chemical Engineering, Cambridge University Press, 2006.

Reference books:

1. B.A. Finlayson, Introduction to Chemical Engineering Computing, John Wiley, 2006

2. A.Constantinides and N.Mostoufi, Numerical Methods for Chemical Engineers with MATLAB Applications, Prentice Hall, 1999.

3. A.Varma and M.Morbidelli, Mathematical Methods in Chemical Engineering, Oxford University Press 1997

4. M.B.Cutlip and M.Shachasm, Problem Solving in Chemical Engineering with Numerical Methods, Prentice Hall, 1999

5. OT.Haanna and IO.C.Sandall, Computational Methods in Chemical Engineering, Prentice Hall, 1995

6. J.H.Mathews and K.D.Fink, Numerical Methods using MATLAB, 4th ed.,Prentice-Hall India Private Limited, 2005

CACE-1.2.4 B. ELECTIVE – III (Process Optimization)

Course Objectives:

Optimization of Chemical Process is an important of subject for Chemical Engineers. It deals with various optimization techniques in reducing cost of production ,energy consumption, maximum throughput and minimum labour cost etc. On studying the course one can understand how to write a model of the process optimize the process using the model

Course Outcomes:

At the end of the course, the student will be able to

* Understand the definition of Optimization and how to write an Objective function

* Understand various types of Objective functions like Concave and Convex functions and its properties

* Study the Optimization of uni&multi dimensional search problems

* Solve the Optimization problems by Linear and Non-Linear Programming methods

SYLLABUS

Definition of optimization Applications of optimization optimal insulation thickness Requirements for an optimization technique, Writing an objective function Production schedule ,material balance requirements , six steps of solving an optimization problem

Basic concepts of optimization continuous and discontinuous , unimodal and multi modal functions concave and convex functions, Finding the optimal point, definition of maximum, minimum and saddle points with examples

Unconstrained unidimensional search , Newton method Quasi Newton method and Secant method, Speed of iterations linear ,order p and super linear, Quadratic interpolation, cubic interpolation, Region elimination method, Fabonacci and Golden section method

Multivariable unconstrained optimization ,direct methods Powell method, Conjugate search direction, Gradient and conjugate Gradient, Fletcher Reeves method , Positive definite of Hessian matrix Marquadt method

Linear programming ,definition , solving the refinery schedule problem by linear programming method using graph, Simplex method and definition

Non linear programming , Lagrange multiplier method, Iterative linearization and Quadratic programming method, Necessary and sufficient condition for a minimum value ,Kuhn-tucker conditions

TEXT BOOKS:

1. Optimization of Chemical Process by Edgar and Himmelblau, 2nd edition, Mc GrawHill Publications.

2 Optimization Theory and Applications by S.S. Rao, 2nd Edition, Wiley Eastern Limited.

3 Formulation and optimization of Mathematical Models by C.L.Smith, R.W. Pike and P.W.Mur.

CACE 1.2.4 C-ELECTIVE – III (Neural Networks)

SYLLABUS

Theory

1. Introduction to the theory of Artificial Neural networks, unsupervised learning.

2. Back propagation and its variations; General approximation for feed-forward neural networks

3. Radial basis neural networks and generalized regression neural networks Applications

4. Application of neural networks in process dynamics, process modeling of fault detection using neural networks.

5. Modeling chemical process using multi resolution representation neural networks

6. Neural networks based control strategies for a continuous polymerization reactor

7. Statistical and neural methods in classification and modeling.

Text-book

A.B.Bulsari, Neural Networks for Chemical Engineers, Elsevier, 1995.

Reference books

1. I.M. Mujtaba and M.A. Hussain, Application of Neural Networks and other learning technologies in Process Engineering, World Scientific Publishing Company, 2006

2. D.R. Baughman, Y.A. Liu, Neural Networks in Bioprocessing and Chemical Engineering, Academic Press, 1995.

3. S.N. Sivanandam, S.Sumathi and S.N. Deepa, Introduction to Neural Networks using MATLAB-6, Tata McGraw-Hill , New Delhi, 2006

CACE-1.2.5- ELECTIVE-IV

CACE-1.2.5 A-ELECTIVE-IV (Corrosion Engineering-II)

Common for M.Tech (Chemical, MPE, IPCE, CACE & Biotechnology)

Objectives:

* To enable the principles of corrosion, common corrosion forms, uniform, galvanic, pitting, inter granular, crevice, dezincification, stress corrosion, corrosion fatigue, hydrogen embrittlement corrosion control methods, and material selection to reduce corrosion cost.

* To enable the ability to understand electrochemical fundamentals

* To enable the ability to understand corrosion preventing methods

Outcome:

* The student would know application of weight loss method

* The student would know application of cathodic protection, anodic ptotection

* At the end of this course, the student would know effective surface preparation of specimen can be done

* After completion of this course, the student would understand the causes and the mechanisms of various types of corrosion, including uniform corrosion, galvanic corrosion, crevice corrosion, pitting corrosion, intergranular corrosion.

* The student would know application of Corrosion Processes and Evans Diagrams and application of electroplating, coatings and importance of inhibitors.

SYLLABUS

Corrosion in selective environments: Marine, Acids (Sulfuric acid, Hydrochloric acid, Nitirc acid, Phosphoric acid) Biological and industrial gases (SO_2 H_2S).

* Able to understand corrosion and its mechanism in marine atmosphere.

* Able to understand corrosion in acidic media like Sulfuric acid, Hydrochloric,etc.

Corrosion Testing - Purposes, Materials and specimen. Surface preparation, Measuring and weighing , Exposure Techniques - duration, Planned - Interval Tests, Aeration, cleaning specimens after exposure, Temperature, Standard expression for corrosion rates - Galvanic Corrosion, Erosion Corrosion, crevice Corrosion, Intergranular corrosion, test for stainless steels, warren test pitting, stress corrosion, Paint tests, Sea Water tests, Presenting and summarizing data - Nomo graph for corrosion rates and interpretation of results.

* Able to understand the importance of surface preparation.

* Able to understand the application of Standard expression for corrosion rates using weight loss method.

* Able to understand the application of different corrosion tests.

Cathodic and anodic protection, surface preparation for coatings and chemical conversions: Degreasing, Descaling , Polishing - Anodized coating : anodizing oxidizing, chromate coating, phosphate coatings - Metallic coatings : Hot dipping, cementation, vapor deposition of metallic coating; Sprayed coatings: flame spraying plasma spraying, Galvanizing - Electroplating : Nickel & chromium coatings, chromizing.- Organic coatings : paints, enamels, lacquers, resin mixtures.

* Able to understand the application of Cathodic and anodic protection.

* Able to understand the uses of Degreasing, Descaling , Polishing.

* Able to understand the importance of Hot dipping, cementation, vapor deposition of metallic coating.

Linings, laminates, reinforced plastic, fibre glass - Corrosion inhibitors: mechanism of inhibition, recirculating of water of water systems.

* Able to understand the importance of Corrosion inhibitors and mechanism of inhibition.

Measurement and testing of preventive coatings ; Thickness and Resistance tests for anodized, Painted, electroplated surfaces using polarization resistance, Linear polarization, curve fit analysis and Electrochemical impedance spectroscopy.

* Able to understand the Thickness and Resistance tests.

* Able to understand the linear polarization and curve fit analysis.

Reference books :

1. Mars G.Fontana - Corrosion Engineering

2. Burns, R.M., Bradley, W.W., 'protective coatings for Metals.' Chapters 2 to 18.

Reference Books :

Corrrosion Volumes 1 & 2 by L.L. Shrier, Newnes - Butter-worths, London.

CACE- 1.2.5 B - Elective-IV (Energy Engineering-II)

Common for M.Tech (Chemical, MPE, IPCE, CACE & Biotechnology)

Course objectives:

1. The student is provided with the fundamentals of renewable energy processes.
2. Basic information to comprehend the various non-conventional energy systems would be illustrated to the student.
3. Various ways of obtaining energy from ocean can be demonstrated to the student.
4. The methods of energy conservation and the opportunities for conservation would be emphasized.
5. Economics involved in the energy production processes would be enumerated to the student.

Course Outcomes:

1. Methods to be adopted to utilize biomass as an important energy source
2. Application of thermodynamics to obtain energy from various sources
3. Possible mechanism to draw energy from wind and other natural resources
4. Knowledge about energy conservation and storage
5. Emerging technologies to produce energy such as thermionics, thermoelectricity etc.

SYLLABUS

Fundamentals of energy science and technology: Introduction – Energy, economy and social development – Oil crisis of 1973 – classification of energy sources – consumption trend of primary energy resources – importance of non-conventional energy sources – energy chain – common forms of energy – advantages and disadvantages of conventional energy sources – salient features of non-conventional energy sources – energy densities of various fuels – environmental aspects of energy – The United Nations Framework Convention on Climate Change – Energy-environment-economy – World energy status – energy scenario in India. Energy conservation and efficiency:

Introduction – important terms and definitions – important aspects of energy conservation – global efforts, achievements and future planning – energy conservation/efficiency scenario in India – energy audit – energy conservation opportunities – cogeneration – combined cycle plants. Energy storage: Introduction – necessity of energy storage – specifications of energy storage devices – energy storage methods.

Learning outcomes:

1. The student can identify the ways and means of conservation of energy once the student completes learning this unit.

2. The student can appraise the necessity of energy storage and recommend the methods for energy storage at the end of the unit.

Wind energy: Introduction – origin of winds – nature of winds – wind turbine siting – major applications of wind power – basics of fluid mechanics – wind turbine aerodynamics – wind turbine types and their construction – wind energy conversion systems – wind-diesel hybrid system – effects of wind speed and grid condition – wind energy storage – environmental aspects – wind energy program in India.

Learning outcomes:

1. By studying this unit, the students will be able to predict where the wind power plants can be located.

2. At the end of this unit, the students can recommend appropriate technology for obtaining geothermal energy in a given situation.

Biomass: Introduction – Photosynthesis process – usable forms of biomass, their composition and fuel properties – biomass resources – biomass conversion technologies – urban waste to energy conversion – biomass gasification – biomass liquefaction – biomass to ethanol production – biogas production from waste biomass – energy farming. Geothermal energy: Introduction – applications – origin and distribution of geothermal energy – types of geothermal resources – analysis of geothermal resources – exploration and development of geothermal resources – environmental considerations – geothermal energy in India.

Learning outcomes:

1. After completing this unit, the students will be able to choose appropriate biogas plant for a given location and able to provide dimensions of the same. .

2. At the end of this unit, the students will be able to recommend a process for utilizing the biomass for a given application.

Ocean Energy: Introduction: Tidal energy – wave energy – ocean thermal energy. Small hydro resources: Introduction – advantages and disadvantages of small hydro schemes – layout of a micro-hydroscheme - water turbines – turbine classification, characteristics and selection – generators – present status.

Learning outcomes:

1. At the end of this unit, the students can recommend appropriate technology for obtaining energy from ocean in a given situation.

2. Suitable scheme for generating electricity from small hydroresources can be suggested by the student after the completion of this unit.

Emerging technologies: Introduction – fuel cell – hydrogen as energy carrier. Miscellaneous non-conventional energy technologies: Introduction – magneto hydrodynamic power conversion – thermoelectric power generation – thermionic power conversion. Financial and economic evaluation: Introduction – basic terms and definitions – calculations for the case of single payment – calculation for uniform series of payments – calculations for uniform gradient series of payments – calculations for geometric gradient series of payments – effect of inflation on cash flows – comparative economic evaluation of alternatives – effect of depreciation and tax on cash flow.

Learning outcomes:

1. New technologies for obtaining energy from various renewable sources can be evaluated by the student.

2. Economic factor in the energy production by various technologies can be compared by the student at the end of this unit.

Text book:

Non-Conventional Energy Resources by B.H. Khan, 3/e, McGraw Hill (2017).

Reference book:

Fundamentals of Renewable Energy Processes by Aldo V. Da Rosa. Elsevier (2005).

CACE- 1.2.5 C - Elective-IV (Reaction Engineering-II)

Common for M.Tech (Chemical, MPE, IPCE, CACE & Biotechnology)

SYLLABUS

UNIT - I : Laboratory Reactors - Interpretation of Experimental Data - Interpretation of Laboratory Kinetics Data - Homogeneous and Heterogeneous Laboratory Reactors. Calculation of Global Rate - The structure of Reactor Design. (Scope: Chapter 12 of J.M Smith 3rd Edition)

UNIT - II : Design of Heterogeneous Catalytic Reactors Isothermal and Adiabatic Fixed Bed Reactors Non-isothermal, Non-adiabatic Fixed Bed Reactors. (Scope: Chapters 13.1 - 13.9 of J.M Smith 3rd Edition)

UNIT - III : Design of fluidized bed Reactors - Two -Phase Fluidized Bed model - Operating characteristics - Slurry Reactors - Trickle - Bed Reactors - Optimization. (Scope: Chapter 13.10 - 13.13 of J.M Smith 3rd Edition.)

UNIT - IV : Fluid - Solid Noncatalytic Reactions - Design concepts - Single Particle Behavior - Reactor Models. (Scope: Chapter 14 of J.M Smith 3rd Edition)

UNIT - V : Short notes from the portions of all the above four units. Four bits are to be answered out of 7 bits (Not more than 2 bits to be given from any one Unit).

Text Book:

Chemical Engineering Kinetics by J.M Smith, McGraw - Hill Book Company , 1980, 3rd Edition.

CACE 1.2.6: AUDIT COURSE -2

CACE 1.2.6 A : DISASTER MANAGEMENT (Audit Course -2)

Common for M.Tech (Chemical, MPE, CACE, IPCE, Biotechnology)

Introduction to Disaster: Definition, Factors And Significance; Difference Between Hazard And Disaster; Natural And Manmade Disasters: Difference, Nature, Types and Magnitude.

Repercussions Of Disasters And Hazards: Economic Damage, Loss of Human And Animal Life, Destruction Of Ecosystem. Natural Disasters: Earthquakes, Volcanisms, Cyclones, Tsunamis, Floods, Droughts And Famines, Landslides And Avalanches, Man-made disaster: Nuclear Reactor Meltdown, Industrial Accidents, Oil Slicks And Spills, Outbreaks Of Disease And Epidemics, War And Conflicts.

Disaster Prone Areas in India Study Of Seismic Zones; Areas Prone To Floods And Droughts, Landslides And Avalanches; Areas Prone To Cyclonic And Coastal Hazards With Special Reference To Tsunami; Post-Disaster Diseases And Epidemics

Disaster Preparedness And Management Preparedness: Monitoring Of Phenomena Triggering A Disaster Or Hazard; Evaluation Of Risk: Application Of Remote Sensing, Data From Meteorological and Other Agencies, Media Reports: Governmental And Community Preparedness.

Risk Assessment Disaster Risk: Concept and Elements, Disaster Risk Reduction, Global and National Disaster Risk Situation. Techniques of Risk Assessment, Global Co-Operation In Risk Assessment and Warning, People's Participation In Risk Assessment. Strategies for Survival

Disaster Mitigation Meaning, Concept and Strategies Of Disaster Mitigation, Emerging Trends In Mitigation. Structural Mitigation And Non-Structural Mitigation, Programs Of Disaster Mitigation In India.

REFERENCES:

1. R. Nishith, Singh AK, "Disaster Management in India: Perspectives, issues and strategies "'New Royal book Company.

2. Sahni, PardeepEt.Al. (Eds.)," Disaster Mitigation Experiences and Reflections", Prentice Hall Of India, New Delhi.

3. Goel S. L., Disaster Administration And Management Text And Case Studies",Deep & Deep Publication Pvt. Ltd., New Delhi.

CACE 1.2.6 B: ENTREPRENEURSHIP (Audit Course -2)

Common for M.Tech (Chemical, MPE, CACE, IPCE, Biotechnology)

Unit -I : Basic Concepts of Management:Management :- Definition, Nature and Importance ; Functions of the Management; Levels of Management; F.W Taylor's Scientific Management; Henry Fayol's Principles of Management.

Unit-II : Forms of Business Organizations: Introduction, Types of Business organizations: Private Sector- Individual Ownership , Partnership, Joint stock companies and Co-Operative organizations; Public sector- Departmental Organizations, Public Corporations and Government Companies; The Joint sector Management.

Unit-III Production and operations Management: Plant location- Factors to be considered in the selection of Plant location; Break - even analysis-Significance and managerial applications; Importance of Production Planning and Control and its Functions; Human Resource Management and Functions of Human Resource Manager (in brief); Functions of Marketing; Methods of Raising Finance.

Unit-IV : Entrepreneurship: Definition, Characteristics and Skills, Types of Entrepreneurs, Entrepreneur vs. Professional Managers, Growth of Entrepreneurs, Nature and Importance of Entrepreneurs, Women Entrepreneurs, Problems of Entrepreneurship.

Unit-V : Entrepreneurial Development and Project Management: Institutions in aid of Entrepreneurship Development, Idea generation: Sources and Techniques; Stages in Project formulation; Steps for starting a small enterprise - Incentives for Small Scale Industries by Government.

Text Books:

1. Sharma, S.C, and Banga, T.R., Industrial Organization & Engineering Economics, Khanna Publishers, Delhi, 2000.

2. Vasant Desai, The Dynamics of Entrepreneurial Development and Management (Planning for future Sustainable growth), HImalayan Publishing House, 2018.

Reference Books:

1. Aryasri, A.R., Management Science, McGraw HIll Education (India Private Limited, New Delhi 2014.

2. Sheela, P. and Jagadeswara Rao, K., Entrepreneurship, Shree Publishing House, Guntur,

III SEMESTER

CACE-2.1.1: Elective –V

CACE-2.1.1 A : Elective-V (Process Modeling and Simulation)

Common for M.Tech (Chemical, MPE, CACE & IPCE)

Objective:

Deals with writing various process models based on basic physical process. It also deals with solving the various models by means of numerical methods by computer simulation. By studying this course, one can simulate various chemical processes by computer simulation.

Outcome:

Understand the writing of a model of a process based on basic physical processes like mass, momentum and energy balances.

1. Able to develop a model equation for Tanks, Isothermal and Non-Isothermal Systems

2. Able to understand the models for binary distillation column, batch reactors, etc.

3. Able to solve the model equations by numerical methods.

SYLLABUS

Principles of formulation - Continuity equations – Energy equation – Equation of motion – Equations of state – Transport equations – Chemical Kinetics – Algebraic and Integral / differential equations, Explicit and Implicit equations –Numerical Integration,Feed forward and feed backward control.

Basic modeling for tank system, mixing vessel – Simultaneous mass and energy balances – Models for boiling, batch distillation, and partial condenser.

Models for Reactor – Model for heterogeneous catalysis – Models for pumping system – Model for heat exchanger.

Operational blocks in simulation- Simulation Programming – Simulation examples of three CSTR's in series, gravity flow tank, binary distillation column, non–isothermal CSTR.

Implicit function convergence ,Internal–halving convergence, Newton–Raphson method, False position convergence, Explicit convergence methods, Numerical Integration, Euler Integration, Runge - Kutta (fourth order) method.

Textbooks:

1. Process Modeling, Simulation and Control for Chemical Engineers by Luyben, W.L., McGraw Hill Books Co.

2. Mathematical Modeling in Chemical Engineering by Roger, G.E. Franks – John Wiley Sons Inc.

Reference Book:

Mathematical Methods in Chemical Engineering by V.G. Jenson and G.V. Jefferys, Academic Press – 2nd Edition.

CACE-2.1.1 B-ELECIVE-V(BIOINFORMATICS)

SYLLABUS

1. Introduction, Molecular Biology and Bioinformatics, Biological database: Primary, Secondary and Structural data bases, tools for web search, data retrieval tools.

2. Genome analysis and gene mapping: sequence assembly problem, genetic mapping and linkage analysis, genome sequencing, sequence assembly tools, Human genome project.

3. Alignment of pairs of sequences, scoring matrices, multiple sequences, phylogenetic analysis, Tree evaluation, automated tools for phylogenetic analysis, working with FASTA and BLAST.

4. Gene identification and prediction: Basis for gene prediction, pattern recognition, gene prediction methods, working with DNA, Micro arrays, Micro array analysis.

5. Protein classification and structure visualization: structure – based protein classification, protein structure databases, visualization databases and tools, protein structure alignment, tools for plotting protein-ligand interaction.

6. Protein structure prediction: Analysis and prediction of primary structure and secondary structure, motifs, profiles, patterns and fingerprints search, Ab Initio approach, 2-D structure prediction, protein function prediction from DNA sequence.

7. Proteomics: Tools and techniques in proteomics, protein – protein interactions, gene family identification methods. Computational Methods for pathways and systems Biology: Analysis of pathways, metabolic network properties, metabolic control analysis, simulation of cellar activities.

Text-book:

S.C..Rastogi, N.Mendiratta and P.Rastogic, Bioinformatics, Prentice- Hall of India Pvt.Ltd, New Delhi, 2004

Reference books:

1. T.K.Attwood and D.J. Parry-Smith, Introduction to Bioinformatics, Pearson Education Asia, Delhi, 2002

2. A.M. Lesk, Introduction to Bioinformatics, Oxford University press, New Delhi, 2004.

4. Boundary Value Problems (BVPs) BVPs from conservation principles, real space versus function space methods, finite difference methods for 2-D

BVP, extension of finite difference method, chemical reaction and diffusion in spherical catalysts pillet, conversion/diffusion equation, modeling a tubular reactor with dispersion, numerical issues for discretized PDEs with more than tow spatial dimensions, finite differences in complex geometries, finite volume method, finite element method (FVM).

Text book:

K.J.Beers, Numerical Methods for Chemical Engineering, Cambridge University Press, 2006.

Reference books:

1. B.A. Finlayson, Introduction to Chemical Engineering Computing, John Wiley, 2006

2. A.Constantinides and N.Mostoufi, Numerical Methods for Chemical Engineers with MATLAB Applications, Prentice Hall, 1999.

3. A.Varma and M.Morbidelli, Mathematical Methods in Chemical Engineering, Oxford University Press 1997

4. M.B.Cutlip and M.Shachasm, Problem Solving in Chemical Engineering with Numerical Methods, Prentice Hall, 1999

5. OT.Haanna and IO.C.Sandall, Computational Methods in Chemical Engineering, Prentice Hall, 1995

6. J.H.Mathews and K.D.Fink, Numerical Methods using MATLAB, 4th ed.,Prentice-Hall India Private Limited, 2005

CACE-2.1.1 C : Elective-V (Advanced Engineering Mathematics & Statistics)

Common for M.Tech (Chemical & CACE)

Objective:

The main objective is to make the students get familiar with the Advanced Numerical Methods and Statistical techniques by learning them. The student should be able to learn how to get the Numerical solutions of Boundary value problems as these arise in several engineering studies, such as in Hydrodynamics, Quantum mechanics, applied elasticity, Heat and Mass transfer etc. The student should be able to study about Probability and Statistics; which provides a mathematical frame work for different assertions and is essential in every decision-making process.

Outcome:

The Students come out with the good knowledge of Advanced Numerical Methods and Statistical Techniques and they will be able to implement these techniques whenever required in their further studies.

SYLLABUS

1. Finite Difference Methods of Solving Boundary value problems Associated with partial Differential Equations: Introduction, Finite difference scheme for Laplace's equation, Finite difference methods for the parabolic type of partial differential equations, Forward difference method, Crank-Nicholson implicit method, Stability analysis, backward difference equation for parabolic equations, finite difference explicit scheme for the wave equation. An implicit scheme for the linear wave equation, method of characteristics for solving hyperbolic partial differential equations.

2. Boundary value problems in ordinary differential equations: Reduction to an intial value problems, Finite difference method, The shooting method, Multiple integration.

3. Statistics and probability: Concept of random variable – distribution and density functions conditional distribution and density functions, Functions of one and two random variables, Many random variables, Concept of Stochastic Processes.

Textbooks:

1. Computer Programming and Numerical Analysis by N.Datta Published by Universities Press(India) Private Limited, 3-5-819, Hyderabad – 500029 for Section I & II.

2. Probability by Seymour Lipschutz: Schaum's outline series for Section III.

3. Introductory Methods of Numerical Analysis by S.S.Sastry.

CACE-2.1.2: Elective –VI (Open Elective)

CACE-2.1.2 A : Elective-VI (Nanotechnology)

Common for M.Tech (Chemical, MPE, CACE, IPCE, Biotechnology)

Objectives:

Nanotechnology may be treated as Green technology. It is one of the most advanced technologies now-a-days. It leads to have revolutionary changes in the fields of medical, Bio-medical, and fabrication of materials. Technologists are able to prepare ageless materials with the help of nano-techniques. Main objectives of the subject nanotechnology are :

1. To define green technology properly
2. To expose the students with new techniques of the nanotechnology.
3. To make them to learn the importance of quantum technology
4. To learn the procedure ageless materials to avoid wear-tear.
5. To learn the importance of nano –robots, machines

6. To know about the latest microscopes such as SEM, TEM

7. To know the importance of nanotechnology in the dawn of optical instruments

Outcome:

1. Application of nanotechnology in the development of energy

2. Application of nanotechnology in the development of solar panels, Fuel cells

3. Knew the importance of atoms manipulation

4. Knew that the applications of nanoparticles in the development of DVD, LEDs etc.

5. Biomedical applications in terms of preparing artificial, drug delivery, encapsulation, addition to that pharmaceuticals.

SYLLABUS

1. Introduction to nanotechnology, molecular and atomic size, surface and dimensional spaces. Molecular nanotechnology: atoms by inference, electron microscopes, nanomanipulator, nanotweezers, atom manipulation, nanodots, nanolithography.

Learning Outcomes:

* Define the term nanotechnology to understand in a better way the subject basics

* Demonstrate the different types of Electron Microscopes and their uses.

2. Nanopowders and nanomaterials: preparation, plasma arcing, chemical vapor deposition, sol-gels, electrodeposition, Ball milling, applications. Carbon nanotubes: types, formation, assemblies, purification, properties and uses.

Learning Outcomes:

* Summarize the nanomaterials used for the preparation of nanopowders

* Apply and selection of the different methods to prepare nanopowders

* Classify the carbon nanotubes and purification process.

3. Molecular mimics: Catenanes and rotaxanes, various molecular switches, synthesis of rotaxanes and catenanes, molecular computers, chemical rotors, prodders, flippers, atom shuttles, actuators, contacts.

Learning Outcomes:

* Categorize the molecular switches and synthesis of rotaxane and catenanes

* Examine the function of molecular computers

4. Nanobiometrics: Lipids as nano-bricks and mortar, self – assembled monolayers, proteins, 3-D structures arising from amines acids, nanoscale motors, Biological Computing, ion channels as sensors, Information in DNA structure, using DNA to build nano-cubes, hinges, smart glue, wire template.

Learning Outcomes:

* Evaluate the importance of nanobiometrics as self-assembled monolayers and nanoscale motors.

* Explain the process of biological computing and using DNA as hinges, smart glue, wire template

5. Optics, photomics and solar energy: Properties of light and nanotechnology, Interaction of light and nanotechnology, Nanoholes and photons, Imaging, New low cost energy efficient windows and solar absorbers based on nanoparticles, Photonic crystals, surface wave guides and control of light paths.

Learning Outcomes:

* Discuss about the optics, photomics and solar energy with reference to light properties.

* Chose a technique using nanoparticles to manufacture solar absorber, photonic crystals and change the light path.

6. Nanoelectrons: birth of electrons, semiconductors, transistor, integrated circuits, the tools of micro and nanofabrication, quantum electronic devices, quantum information and quantum computers, experimental implementations of quantum computers.

Learning Outcomes:

* Appraise different phased in the development of nanoelectornics tools.

* Construction of quantum computers and its experimental implementations.

7. Future applications: microelectomechanical systems, nano-robots , ageless materials, invisible mending of atomic dislocations inside damaged materials, nanomechanics and nanoelasticity, nanoparticle coatings, nanoelectronic and magnetic devices and new computing systems, optoelectronic devices, environmental applications.

Learning Outcomes:

* Assess the future application of nanotechnology in various fields

* Create new tools with nanotechnology to prepare new devices

Text-book:

1. M.Wilson, K.Kannangara, G. Smith, M. Simmons and B. Ragues, Nanotechnology, Overseas press (India) Private Ltd; New Delhi, 2005.

Reference books:

1. G. Ali Mansoori*, Principles of Nanotechnology, World Scientific Publishing Company, 2005.

2. G. Timp, Nanotechnology, Springer-Verlag, Network, 1999.

3. P. Poole and F.J. Owens, Introduction to Nanotechnology, John Wiley, 2003.

4. D.Ratner and M.Ratner, Nanotechnology: A Gentle Introduction, Pearson Education,2003.

5. B. Bhusan, Handbook of Nanotechnology, Springer, 2004

CACE-2.1.2 B: Elective-VI (POLLUTION CONTROL)

Common for M.Tech (Chemical, MPE, CACE, IPCE, Biotechnology)

Objectives:

* Focus on classification of air pollutants, water pollutants and solid waste –causes, effects and control methods, need of environmental Legislation.

Outcome:

* Enables the students to adopt the preventive measures for the control of air pollutants, waste water treatment methods, and solid waste management methods in domestic, municipal waste.

* Enables the students to understand the control measures of pollutants emitted from different industries like Paper and pulp, fertilizer, sugar and alcohol, petrochemical and petroleum refinery, pharmaceutical and metal finishing industries.

SYLLABUS

Kinds of ecology, environment and ecofactors, types of ecosystems, sulphur cycles, phosphorous cycle, Nitrogen cycle and hydrological cycle Sources for water, Air and solid pollution, Analysis and effects of the pollutants in air, in water, Solids(particulate matter, SOx, NOx, Cox, CHx). Limits of pollutants, Environmental Legislation.

Control aspects of various pollutants Air (Particulate matter, SOx, NOx, COx, CHx, Noise) water (primary, secondary and territory treatment techniques) Solids (recycling, incineration,bio-conversion).

Case studies of Industries: Paper and pulp, petrochemical, Fertilizer, Pharmaceuticals, tannery, sugar and alcohol industries, metal finishing industries.

Learning Outcomes:

* Describe different ecosystems

* Explains the bio-geochemical cycles

* classify the main types of pollution and their effects

* Describe the sources of pollution and their characteristics

* Describe the effects of air and water pollution on the environment and on human health

* Explain the importance of Environmental Legislation for pollution prevention and control

* Evaluate the preventive measures for the control of air pollutants – SPM

* Select the most appropriate technique to control SOx, NOx, COx, CHx

* Describe the primary, secondary and territory treatment techniques waste water treatment methods

* Propose control measures of pollutants emitted from different industries like paper and pulp

* Plan to select most appropriate technique to control pollutants from petrochemical and refineries

* Explain the control aspects of pollutants from Fertilizer, Pharmaceuticals

* Elucidate the control aspects of pollutants from tannery, sugar and alcohol industries, metal finishing industries

Text books:-

1. S.P.Mahajan., Pollution control in process Industries, Tata McGraw hill publishing company.

2. Arcadio P. Sincero and Georgia Sincero., Environmental Engineering

3. Environmental Pollution Control., by C.S.Rao, wiely eastern ltd.

CACE-2.1.2 C: Elective-VI (Corrosion Engineering)

Common for M.Tech (Chemical, MPE, CACE, IPCE, Biotechnology)

Course Objectives:

* Basic aspects of electrochemistry relevant to corrosion phenomena,

* Importance and forms of corrosion.

* Knowledge on corrosion rate expressions and measurement techniques.

* Basic knowledge on remedial measures for corrosion.

Course Outcomes:

At the end of the course, the student will be able to

* Identify various forms of corrosion.

* Determine corrosion rates for metals from their polarization curves

* Analyze corrosion rate characteristics from electrochemical impedance spectroscopy

* Select suitable corrosion resistant coatings, oxide layers for various applications

SYLLABUS

Introduction and scope: Corrosion definition, wet and dry corrosion, mechanism, electro-chemical principles and aspects of corrosion, Faradays laws, resistance, specific resistance, conductance, specific conductance, transport numbers, ionic mobility, corrosion rate expressions, calculation of corrosion rates, thermodynamic aspects of corrosion, equilibrium potential, Nernst equation for electrode potential, EMF series, over voltage, application of Nernst equation to corrosion reactions,

Polarisation and corrosion potentials: References electrodes for corrosion measurements, types of polarisation, concentration, activation and resistance polarizations, Tafel constant, Evans diagrams, anodic control, cathodic control, mixed control, Pourbaix-diagram for Fe-H_2O system,

Various forms of corrosion: Uniform attack, galvanic corrosion, crevice corrosion, pitting corrosion, intergranular corrosion, selective leaching (dezincification), cavitation damage, fretting corrosion, erosion corrosion, and stress corrosion and remedial measures,

Prevention techniques: Modification of the material by alloying, appropriate heat treatment, chemical and mechanical methods of surface treatment, metallic, non-metallic linings, inhibitors, passivity, Cathodic protection and anodic protection.

TEXT BOOKS:

1. 'Corrosion Engineering' by Mars G. Fontana, Tata McGraw Hill Publishing Company, New Delhi

2. 'Corosion and Corrosion Control' by H.H.Uhllg, John Wiley & Sons Inc., America

REFERENCE BOOKS:

1. 'Electrochemistry' by Samuel Glasstone, Litton Educational Publishing Company

2. 'Electrochemistry, Principles & Applications' by Edmond C.Potter, Cleaver Hume Press Limited.

SCHEME OF INSTRUCTION & EXAMINATION

1/2 M.TECH (INDUSTRIAL POLLUTION CONTROL ENGINEERING) FIRST SEMESTER

(With Effect From 2021-22 Admitted Batch Onwards)

Under Choice Based Credit System

Code No.	Course	Credits	Theory	Tutorial	Lab	Total	Sessional marks	Exam marks	Total marks
IPCE 1.1.1	Chemical Reaction Engineering	3	3	1	—	4	30	70	100
IPCE 1.1.2	Transport phenomena	3	3	1	—	4	30	70	100
IPCE 1.1.3	Elective-I	3	4	—	—	4	30	70	100
IPCE1.1.4	Elective-II	3	4	—	—	4	30	70	100
IPCE1.1.5	Research Methodology & IPR	2	4	—	—	4	30	70	100
IPCE1.1.6	Audit Course–1*	0	2	-	—	2	—	—	—
IPCE 1.1.7	Elective lab	2	—	—	3	3	50	50**	100
IPCE 1.1.8	Seminar	2	—	—	3	3	100	—	100
	TOTAL	18	20	2	6	28	400	400	800

*To be included as 'Qualified' or 'Not Qualified' in the marks list

**Only internal evaluation.

Elective-I: 1. Management and control of Industrial waste water and Solids
2 Petroleum Refinery Engineering-I
3. Electrochemical Engineering - I

Elective-II: 1. Corrosion Engineering-I
2. Energy Engineering-I
3. Reaction Engineering-I

Audit Course 1 : 1. Yoga for working professionals
2. Organizational Behaviour

1/2 M.TECH (INDUSTRIAL POLLUTION CONTROL ENGINEERING) SECOND SEMESTER

(With Effect From 2021-22 Admitted Batch Onwards)

Under Choice Based Credit System

Code No.	Course	Credits	Theory	Tutorial	Lab	Total	Sessional marks	Exam marks	Total marks
IPCE 1.2.1	Air pollution and control	3	3	1	—	4	30	70	100
IPCE1.2.2	Process Dynamic and Control	3	3	1	—	4	30	70	100
IPCE 1.2.3	Analytical Techniques	3	3	1	—	4	30	70	100
IPCE 1.2.4	Elective-III	3	4	—	—	4	30	70	100
IPCE1.2.5	Elective-IV	3	4	—	—	4	30	70	100

IPCE1.2.6	Audit Course–2*	0	2	-	—	2	—	—	—
IPCE 1.2.7	Elective lab	2	—	—	3	3	50	50	100
IPCE 1.2.8	Seminar	2	—	—	3	3	100	—	100
	TOTAL	19	19	3	6	28	300	400	700

* To be included as 'Qualified' or 'Not Qualified' in the marks list

Elective-III: 1. Industrial Hazards, Safety Measures & Environmental Impact Assessment
2. Petroleum Refinery Engineering-I
3. Electrochemical Engineering - I

Elective-IV: 1. Corrosion Engineering-II
2. Energy Engineering-II
3. Reaction Engineering-II

Audit Course 2 : 1. Disaster Management
2. Entrepreneurship

2/2 M.TECH (INDUSTRIAL POLLUTION CONTROL ENGINEERING) FIRST SEMESTER

(With Effect From 2021-22 Admitted Batch Onwards)

Under Choice Based Credit System

Code No.	Course	Credits	Theory	Tutorial	Lab	Total	Sessional marks	Exam marks	Total marks
IPCE 2.1.1	Elective-V	3	4	—	—	4	30	70	100
IPCE2.1.2	Elective-VI(Open Elective)	3	4	—	—	4	30	70	100
IPCE 2.1.3	Dissertation (preliminary)	9	—	—	—	—	100	—	100
	TOTAL	15	8	—	—	8	160	140	300

Note: The dissertation shall be evaluated through Viva-voce examination by a committee with HOD, Chairman, Board of Studies and Research guide as members. The marks shall be awarded in the ratio of 30,30 and 40 percent by the members Respectively

Elective-V: 1. Environmental Biotechnology
2. Waste to Energy
3. Process modelling & simulation

Elective-VI (Open elective): 1. Nano Technology
2. Pollution Control
3. Corrosion Engineering

2/2 M.TECH (INDUSTRIAL POLLUTION CONTROL ENGINEERING) SECOND SEMESTER

(With Effect From 2021-22 Admitted Batch Onwards)

Under Choice Based Credit System

Code No.	Course	Credits	Theory	Tutorial	Lab	Total	Sessional marks	Exam marks	Total marks
IPCE 2.2.1	Dissertation	16	—	—	—	—	—	100	100
	TOTAL	16	—	—	—	—	—	100	100

Note: The dissertation shall be evaluated through Viva-voce examination by a committee with an external member nominated by University, HOD, Chairman, Board of Studies and Research guide as members. The marks shall be awarded in the ratio of 20, 20, 20 and 40 percent by the members respectively

SYLLABUS

M.TECH. I SEMESTER

IPCE-1.1.1: Chemical Réaction Engineering

(Common for Chemical, MPE, CACE & IPCE)

Objectives:

* To focus on the thermal characteristics of various reactions and the design aspects of non isothermal and adiabatic reactors

* To focus on Heterogeneous data analysis and design

* To focus on CVD reactors

* To study the design aspects of heterogeneous catalytic systems

* To impart the knowledge on mass transfer with reaction in process catalysts

Outcome:

* Enables the students to understand the design aspects of non isothermal and adiabatic reactors

* Enables the students to on heterogeneous data analysis and design aspects of heterogeneous catalytic systems

* Able to derive the rate laws for CVD

* Able to develop the rate laws for heterogeneous fluid solid catalyzed reactions under rate limiting situations.

SYLLABUS

Review of Fundamentals Rate laws and stiochiometry, reactions with phase change (Scope: Chapter 3 of Fogler) Least squares Analysis of rate

data: differential reactors: Laboratory reactors (Scope: sections 5.4 to 5.6 of Fogler) Multiple reactions (Scope: Chapter 9 of Fogler).

Isothermal reactor design (Scope: Chapter 4 of Fogler) Batch reactor, PFR, CSTR design. Pressure drop in reactors, Reversible reactions, unsteady state operation of reactors, Simultaneous reaction and separation

Catalysis and catalytic reactors (Scope: Chapter 6 of Fogler) Steps in catalytic reaction: derivation of rate laws, design for gas-solid reactions, heterogeneous data analysis and design; Chemical vapour deposition, catalyst reactivation, moving bed reactions.

Diffusion and reaction in process catalysts (Scope: Chapter 11 of Fogler).

Diffusion and reaction in spherical catalyst.

Internal effectiveness factor, falsified kinetics; estimation of diffusion and reaction limited regimes. Mass transfer and reaction in packed bed. Determination of limiting situations from reaction data, CVD reactors.

Non-isothermal reactor design (Scope: Chapter 8 of Fogler), Energy Balance, equilibrium conversion under adiabatic conditions unsteady state operation, multiple steady states.

Learning outcomes:

* Express important concepts in reaction kinetics and classify reactions according to different properties.

* Calculate the reaction rate constant and reaction activation energy using Least squares Analysis of rate data

* Explain

* Explain the criteria used to evaluate the laboratory reactors and solve problems related to multiple reactions

* develop performance equations for different types of reactors using mass balances

* Design different reactors and explains the Simultaneous reaction and separation.

* Develop the rate laws for heterogeneous fluid solid catalyzed reactions under rate limiting situations.

* Develop the expression for concentration profile and effectiveness factor for first order reaction in a spherical pore of a catalyst.

* Explain different mechanisms postulated for adsorption and surface reaction in catalytic reactions.

* Explain the mass transfer and reaction in a packed bed.

* Do design calculations for non isothermal and adiabatic reactors

* Investigate the effect of temperature on reactor design and reaction parameters.

* Calculates the multiple steady states for MFR type reactors

Textbook:

Fogler. H.S: Elements for Chemical Reaction Engineering 2nd Edition, Prentice Hall, New Delhi, 1992.

Reference:

Smith J.M: 'Chemical Engineering Kinetics' 3rd Edition, McGraw Hill, 1981.

IPCE -1.1.2: Transport Phenomena
(Common for Chemical, MPE, CACE & IPCE)

Objectives:

* To be able to analyze various transport processes with understanding of solution approximation methods and their limitations.

Outcomes:

* Ability to understand the chemical and physical transport processes and their mechanism.

* Ability to do heat, mass and momentum transfer analysis.

* Ability to analyze industrial problems along with relevant approximations and boundary conditions.

* Ability to develop steady and time dependent solutions along with their limitations.

SYLLABUS

Unit 1: Momentum Transport : 1.1 The Equations of change for isothermal systems. 1.2 Velocity distributions with more than one independent variable. 1.3 Velocity distributions in turbulent flow. 1.4 Inter phase transport in isothermal systems.

At the end of the course, the student will be able to:

* Perform momentum balance for a given system at microscopic scale.

* Solve the governing equations to obtain velocity profile.

* Solve the unsteady state momentum equation to obtain velocity profiles

* Understand the momentum transport under turbulent conditions and can be able to find out the friction factor or drag coefficient for a fluid flow system

Unit 2: Energy Transport : 1.1 The Equations of change for non – isothermal systems.1.2 Temperature distributions with more than one independent variable.1.3 Temperature distributions in turbulent flow 1.4 Inter phase transport in non isothermal systems.

At the end of the course, the student will be able to:

* Perform energy balance for a given system at microscopic scale.

* Solve the governing equations to obtain temperature profiles at steady state and unsteady state condition.

* Understand the energy transport under turbulent flow conditions and can be able to find out the heat transfer coefficient.

Unit 3: Mass Transport : 1.1 The Equations of Change for multi component systems. 1.2 Concentration distribution with more than one independent variable. 1.3 Concentration distribution in turbulent flow.

At the end of the course, the student will be able to:

* Perform the mass balance for a given system at microscopic scale and can be able to solve the governing equation to obtain concentration profiles.

* Solve the unsteady state mass balanceequation to obtain concentration profiles

* Understand the mass transport phenomena under turbulent flow conditions.

Textbook:

"Transport phenomena" R. Byron Bird, Warren E. Stewart and E.N. Light foot, Wiley & Sons, Inc., New York.

Reference Books:

1."Fundamentals of Momentum, Heat and Mass Transfer" James R. Welty, Charles E. Wicks and Robert E. Wilson, John Wiley & Sons, Inc., New York.

2. "Boundary – Layer Theory", Dr.H.Sehlichting, McGraw – Hill Book Company, New York.

IPCE-1.1.3: Elective – I

IPCE- 1.1.3 A - Elective-I

(Management and control of industrial wastewater and solids)

Course objective:

The course is designed as tailor-made approach to know the fundamental concepts and various technologies of industrial wastes and solid waste management helpful the students in brightening chances for getting wide range of employability both in industrial and community organizations

Course outcome:

* On completion of the subject course, the students will have the scope to learn various theoretical and technical aspects of industries waste water treatment and solid waste management methods which are very significant in industrial sector

* The course will add the design approach of Effluent Treatment Plants and solid waste recovery and recycling techniques and the students can brighten their chances of job opportunity in corporate companies engaged in design of pollution control equipments

* Sludge treatment aspects of the course will be helpful to students for further enhancing their skills when they take up practical assignments

* The course will lay down a basic platform to persue further research in the specific fields the interest of students

* Enhance the knowledge of latest practices being adopted in the field of wastewater treatment and solid waste management and helpful the students who take up their career in academic line

SYLLABUS

Unit – I : Source of Industrial wastewater: Types, permissible limits, sources and pollutants - BOD, COD, TOC, sampling and analysis of industrial wastewater, impacts on - soil, irrigation, animal husbandry, plants, ecosystems and public health aspects

Learning outcome

* The student will learn various types of industrial wastewaters and its permissible limits as per the statutory stipulations

* The student will have knowledge on sources of pollutants, sampling & analysis techniques pertaining to water pollution measures. And also, the aspects like of impacts on soil, irrigation, animal husbandry, plants, eco-systems and public health aspects

Unit – II : Primary and secondary treatment methods: screening, sedimentation, flotation and neutralization, bacterial and bacterial growth curve, aerobic processes, suspended processes, activated sludge processes, extended growth processes, contact stabilization, aerated lagoons and stabilization ponds, attached growth processes, trickling filters, rotary disk contractors, fluidized bed contractors, anaerobic processes

Learning outcome:

* On completion of the course, the student will have the scope to learn various theoretical & technical aspects of industrial wastewater treatment and management methods

* As the aspects related to biological treatment process of the effluents, the student will enhance the skills to design the treatment systems

Unit – III : Tertiary treatment techniques: carbon adsorption, ion-exchange, reverse osmosis, ultra filtration, ozonation, sonozone processes, chlorination

Learning outcome:

* Student will learn the advanced treatment procedures of effluents and expected to gain knowledge in optimizing the operating parameters of the tertiary treatment systems

* The course will laid on a basic platform to pursue further research and the specific fields of the interest of the students in advanced treatment systems

Unit – IV : Sludge treatment and disposal: overview, mass volume relationships, secondary clarification and gravity thickness, aerobic & anaerobic digestion, cake filtration, composting, sludge disposal

Learning outcome:

* This module will give a overview of sludge treatment and disposal systems being practiced in the industries

* The sludge treatment aspects of the course will be helpful to the students for further enhancing their skills when they take-up practical assignments

Unit – V : Solid waste Management: Terminology – liquid waste, solid waste, refuse, garbage & food waste, rubbish, white goods, rubble. Solid waste characteristics – generation rates, components, moisture content, density, proximate and ultimate analysis and energy content, solid waste collection & transportation – haul – container system, stationary container system, layout of collection routes, transfer stations, solid waste processing and recovery – recovery of materials for recycling, manufacturing of solid waste products, energy recovery, disposal of solid wastes – land filling methods, aspects of landfill implementation, sanitary landfill equipment

Learning outcome:

* This module will help the student to learn about broad classification of solid waste and its characteristics like moisture content, density, proximate and ultimate analysis etc.

* It is expected to learn various methodologies adopted in solid waste management including handling, transportation and treatment. And also, the principles of reduce, recycle & reuse (3R) will be well-known to the students

Textbooks:

1. "Industrial Pollution Control" by C.S.Rao
2. "Environmental Engineering – A design approach" by Arcadio P. Sincero and Gregoria A. Sincero

IPCE - 1.1.3 B - Elective-I (Petroleum Refinery Engineering-I)

Objective: The objective of this course is to provide with:

Basic concepts of petroleum refinery engineering, refinery process, products, specifications, test methods and design of equipment.

Outcomes: The student will be able to:

* Understand the formation and composition of petroleum and classify important refinery products and their properties.

* Analyze the fractionation of petroleum, treatment techniques, thermal and catalytic process and design of distillation towers.

Syllabus

Origin, formation and composition of petroleum: Origin and formation of petroleum, Reserves and deposits of world, Indian petroleum industry, Composition of petroleum.

Petroleum processing data: Evaluation of petroleum, thermal properties of petroleum fractions, important products and properties, test methods.

Learning outcomes:

* Understand the origin and composition of petroleum, deposits of world.

* Classify the petroleum products and test methods.

Fractionation of petroleum: Dehydration and desalting of crudes, heating of crude-pipe still heaters, distillation of petroleum, blending of gasoline.

Learning outcomes:

* Explain the dehydration and desalting of crudes.

* Analyzing crude pipe still heaters and blending of gasoline.

Treatment techniques: Treatment of gasoline, kerosine, lubes, and wax purification.

Learning outcomes:

* Discuss the treatment of gasoline, kerosine and lubes.

* Explain the wax purification.

Thermal and catalytic processes: Cracking, catalytic cracking, catalytic reforming, coking, alkylation process.

Learning outcomes:

* Explain the catalytic cracking and catalytic reforming process.

* Explain the coking and alkylation process.

Design of atmospheric distillation and vacuum distillation towers.

Learning outcomes:

* Design of atmospheric distillation column.

* Design of vacuum distillation column.

Text book:

Petroleum refinery engineering by Nelson.

Reference Books:

1.Modern petroleum refining process by B.K.Bhaskara Rao.

2.Petroleum refining technology by Dr.Ram Prasad.

IPCE - 1.1.3 C - Elective-I (Electrochemical Engineering-I)

OBJECTIVES:

* To enable the basic principles of electrochemistry, electrochemical devices, electro active materials used in such devices, and case studies of batteries.

* To enable the clean energy needs and demands especially in the electrochemical power generation sector; and to become educators, practicing engineers, and national leaders in electrochemical energy conversion and storage.

* To enable the integrated skills in fundamentals of electrochemistry (e.g.; chemistry, physics, mathematics, thermodynamics, and chemical kinetics) and electrochemical engineering applications (batteries, solar, flow and fuel cells, electrochemical synthesis and corrosion) to ensure successful career opportunities and growth within electrochemical power generation industries and academia.

* To enable the students in energy related programs such as clean power generation and future green technologies.

OUTCOMES:

* The student would know how to solve the problems relating to the production, storage, distribution and utilization of electrochemical energy and the associated environmental issues. And he would know integration of electrochemical principles and materials science for application in modern electrochemical devices.

* The student would know design and conduct experiments, acquire data, analyze, interpret data, solve practical and complex problems on a variety of electrochemical devices such as batteries, solar cells, flow and fuel cells and integrate the professional, ethical, social and environmental factors in electrochemical engineering and understand the impact of these factors on global energy issues.

SYLLABUS

Introduction:

Unit I : Basic Concept: Mechanism of Electrolysis, Laws of Electrolysis, Curent and Voltage Efficiency - Electrolytic dissociation, Coulometers, Ionic conduction. Electrolytic conductivity, Absolute ionic velocities, ionic mobilities, Transference Nos. Modern Ionic Theory, Ionic activity Degree of dissociation. Ionic Atmosphere Time of relaxation and relaxation effect, Electrophoretic effect - Debye - Huckel Onsager equation of conductance (Derivation is not required) and its validity.

* Able to understand the concept and applications of Laws of Electrolysis.

* Able to understand the importance and construction of Coulometers.

* Able to understand about Transference Nos.

* Able to understand Degree of dissociation.

Unit II: Thermodynamics I: Chemical Potential and Free Energy changes. Cell and Electrode potentials. Thermodynamics of Electrode potentials - Nernst Equation. Equilibrium Constant, Arbitrary Zero of potential, EMF series and their limitations Activity Coefficient of and their evaluation, Liquid Junction potentials, Concentration Cells - Reference Electrodes.

* Able to understand the concept of Chemical Potential and Free Energy changes.

* Able to understand how to calculate cell electrode potential.

* Able to understand the application of Nernst Equation.

* Able to understand how to measure Junction potential.

Unit III : Thermodynamics II : Electrode Kinetics, Role of Interface, Electric Double Layer and its capacitance - Irreversible Electrode processes - Irreversibility, Tates of Electrode Processes. Electrode Kinetics Model, Cathodic Hydrogen evolution, Depolarisation - Overpotential, Tafel Equation, Ohmic or resistance Over potential, Concentration overpotential, Oxygen Evolution reaction and Decompostion potential, Ionic Transport by Migration, Diffusion and Convection - Mass transfer.

* Able to understand Electric Double Layer theory.

* Able to understand the concepts of Depolarisation and Overpotential.

* Able to understand importance of Tafel Equation.

Unit IV : Kenetics of Corrosion Processes and Evans Diagrams : Electrokinetic phenomenon - Straming potential, zeta potential and Electro - Osmosis, Electrophoresis, Dorn Effect.

Measurements and Systems Analysis : Conductivity measurements - Conductometric analysis - Titrations, Measurements of pH, potential - potentiometric titrations, Polarography Electrogravimetry, Coulometry. Current Distribution in a cell. Rotating Disc Electrode, Rotating Cylinder electrode, Rough Surface Electrode Limiting Current Technique.

* Able to understand the importance of Evans Diagrams.

* Able to understand the concepts of Osmosis and Electrophoresis.

* Able to understand the importance of Conductometric analysis – Titrations.

* Able to understand about potentiometric titrations.

Unit-V: Potential relations in corrosion cells potentials, pH diagrams in corrosion.

Corrosion theory : Manifestation of corrosion, bases of electrochemical corrosion, amount and intensity of corrosion, Eight forms of corrosion : Uniform attack, Galavanic corrosion, crevice corrosion,Pitting, inter granular corrosion.

Selective leaching, stress corrosion cracking. Conditions leading to pitting attack., environmental factors, hydrogen damage. Corrosion inhibition and prevention : Domestic water supplies, recirculating water systems, corrosion inhibitors, Inhibitors for acid pickling, vapor phase inhibitors. Coatings and paits: Phosphating, Protective metal coatings; cathodic protection and corrosion of buried structures.

* Able to understand the different forms of corrosion.

* Able to understand the preventive techniques of corrosion.

* Able to understand the concepts of Protective metal coatings.

* Able to understand the application of cathodic protection of buried structures.

Textbooks:

1. An Introduction to Electrochemistry by Samuel Glasstone, D. Van Nostrand Company Inc princeton, Affiliated East-West press Pvt. Ltd.

2. Electrochemistry - Principles and Applications by Edmund C. Fotter Oliver Hume Press Ltd., London.

Reference Books:

1. Electrochemical Engineering, Principles, by Geofferey Prentice, The Johns Hopkins University, Prentice Hall, Englewood Cliffs, New Jersy, 07632.

2. Electrochemistry - Bookris and A.K.Reddy.

3. Electrochemical Engineering by C.L.Mantell.

4. Principles of Electrochemical Engineering by L.W.Shemilt.

5. Chemical Engineering Development Centre, Indian Institute of Technology, Madras 600 036.

6. Fontanna and Grene 'Corrosion Engineering'.

IPCE -1.1.4: Elective –II

IPCE -1.1.4 A - Elective-II (Corrosion Engineering-I)

Common for M.Tech (Chemical, MPE, IPCE, CACE & Biotechnology)

Objectives : The main objectives are to provide:

1. Basic aspects of electrochemistry relevant to corrosion phenomena,

2. Importance and forms of corrosion.

3. Knowledge on corrosion rate expressions and measurement techniques.

4. Knowledge on factors influencing corrosion of iron and steel exposed to atmospheric, soil and aqueous medium.

5. Basic knowledge on remedial measures for corrosion.

Outcome: At the end of the course, the student will be able to

1. Acquires knowledge on basic principles of electrochemistry, importance of corrosion.

2. Predict whether corrosion will occur for a particular environment.

3. Estimate corrosion rates and analyze.

4. Identify the type of corrosion and propose viable remedial measures.

SYLLABUS

Basic Concepts and Outlines of Electrochemistry: Fundamentals of Electrochemical reactions, Faraday's Laws Electrolytic and ionic conductance, ionic mobility's, Transport Nos. Galvanic Cell and Electrolytic cells.

Definition and importance of corrosion, Dry cell, analogy, Corrosion Cells, Types of Corrosion Cells- a) Dissimilar electrode cells b) Concentration cells such as a salt concentration cells, differential aeration cells c) differential Temperature cells. Corrosion Rate Expresions - mdd, ipy, cpy, mpy, etc.

LO1: Choose a specific cell for a given situation

LO2: Identify the type of corrosion cell that will form in that particular environment

Corrosion Tendency and Electrode Potentials: Free Energy changes, Development of Nernst Equation for calculation of Half-cell potentials, Hydrogen electrode, Spontaneity of a reaction, Reversible cells and potentials – convention of Sign and calculations of EMF from standard Equilibrium potentials., EMF Series and Galvanic series, Reference Half Cells – Calomel, Silver-Silver Chloride and Saturated Copper-Copper Sulphate Half Cells. Pourbaix Diagram for Iron, Aluminum and magnesium, limitations of pourbaix diagrams.

LO3: Predict the tendency of corrosion to occur

LO4: Identify the corrosion zones based on pH of media

Polarization and Corrosion Rates: Polarization and a Polarized Cell, Causes of Polarization – Concentration Polarization, Activation Polarization and IR drop. Hydrogen Over potentials, combined polarization and Mixed potential theory. Tafel Slopes and Tafel Equation. Graphical method of expressing Corrosion Reactions (Polarization diagrams/Evans diagrams), Derivation of Stern-Geary Equation, Influence of Polarization on Corrosion rates.

LO5: Derive the equations for estimating corrosion rates

LO6: Evaluate and Analyze data for corrosion rates

Passivity: Characteristics of Passivation, Flade potential, behavior of passivators, transpasivity, Theories on Passivity.

Forms of Corrosion: Uniform attack, Galvanic Corrosion, Crevice Corrosion, Pitting, Intergranular Corrosion, Selective Leaching, Erosion Corrosion and Stress Corrosion. Hydrogen damage. Factors influencing,

mechanisms and prevention techniques for all forms of corrosion. Calculation of Corrosion rates using weight lost method and Polarization data. Electrochemical Impedance Spectroscopy.

Effect of Dissolved Oxygen (Air saturated Water, High Partial Pressure of Oxygen and Anaerobic bacteria), Temperature, pH, Galvanic coupling, velocity, dissolved salts concentration. Wet and dry corrosion.

LO7: Identify the type of corrosion

LO8: Recommend proper remedial measures

Textbooks :

1. Corrosion and Corrosion Control by Herbert, H. Uhlig John Wiley and Sons Inc., New York.

2. Corrosion Engineering by Mars F Fontana, McGraw Hill.

3. An Introduction to Electrochemistry by Samuel Glass stone, Affiliated East West Press Pvt. Ltd.,

Reference Books :

1. Corrrosion Volumes 1 & 2 by L.L. Shrier, Newnes - Butter-worths, London.

IPCE - 1.1.4 B - Elective-II (Energy Engineering-I)

Common for M.Tech (Chemical, MPE, IPCE, CACE & Biotechnology)

Objectives:

To lean overview of solar radiation and it's potential for collection to meet the energy needs of mankind and potential for solar energy option. To learn measuring techniques of solar radiation and its compilation.

To learn various design and operational aspects of solar energy collection and storage.

To learn the design and operation of solar energy appliances like liquid flat plate collectors, Solar Air Heaters, Thermal energy storage, Thermal energy storage, Solar Pond, Solar thermal power generation.

To learn theory and application of Photovoltaic cells

Outcome:

The student learns collection and design of various kinds of equipment operated on solar energy. The student learns principles and practice of Photo voltaic cells.

SYLLABUS

The Solar Energy option

Thermal conversion – collection and storage Thermal applications – photovoltaic conversion – wind energy – Energy from Bio – mass – ocean thermal energy conversion.

Solar Radiation

Solar Radiation outside the earths – atmosphere Solar radiation at the Earth's surface – Instruments for measuring Solar Radiation – Solar Radiation data – Solar Radiation Geometry Empirical equations for predicting the availability of Solar Radiation – Solar radiation on tilted surface.

Liquid flat – Plate Collectors

Components of liquid flat plate – various types of collectors – Performance Analysis – Transmissivity – Absorptivity product – Overall loss coefficients and heat Transfer correlations – Collector efficiency heat removal factors – effect of various parameters on performance. Transient Analysis – Testing procedures.

Solar Air Heaters

Various types of solar Heaters – Performance Analysis of a conventional Air Heater – Testing procedures – Concentrating collectors – various types of concentrating collectors cylindrical and parabolic collectors – General receiver collectors.

Thermal energy storage

Sensible heat storage – Latent heat storage – Thermochemical storage

Solar Pond

Description – Performance analysis – Experimental studies – Operational problems.

Solar Air Conditioning and Refrigeration

Heat pump cycle – Coefficient of performance of the heat pumps – solar air-conditioning with absorption – Refrigeration system (Ammonia water and lithium bromide – water systems).

Solar thermal power generation

Thermal and direct electricity generation – Major sub-stations of a solar thermal power plant, Examples of installed systems – Concentration ratio. Temperature and efficiency concepts – Solar farm and tower – Economics.

Photovoltaic Energy Conversion

Photovoltaic Energy Conversion Fundamentals – band theory of solids – Physical processes in a solar cell – Solar cell with light incidence – Solar cell module – Silicon Solar Cells – Copper Sulphate / Cadmium sulphide Solar Cells.(Banasal et at.,chapters 9;Taylor, chapters 6, pages 256-298.

Text Books:

1. Solar Energy: Principles of thermal collection and storage by S.P. Sukhatme, Tata McGraw Hill, New Delhi 1984 (Chapters 2 to 8)

2. Renewable energy sources and conversion technology by N. K. Bansal, M. Kleemann, Michael Mcliss, 1990 (Chapters 2 – 9).

IPCE - 1.1.4 C - Elective-II (Reaction Engineering-I)

Common for M.Tech (Chemical, MPE, IPCE, CACE & Biotechnology)

Unit I : (Scope : J.M. Smith : Chapter 7): Heterogeneous Processes, catalysis, and absorption: Global Rates of Reaction - Types of Heterogeneous Reactions - The nature of catalytic Reactions - The Mechanism of catalytic Reactions - Surface Chemistry and Absorption - Absorption Isotherms - Rates of Absorption.

Unit II (Scope : J. M. Smith: Chapter 8 : Solid Catalysts: Determination of surface area - Void Volume and solid density - Fore volume distribution - Theories of Heterogeneous Catalysis - Classification of catalysts - Catalyst Preparation - Promoters and Inhibitors Catalyst Deactivation (Poisoning).

Unit III: (Scope: J.M. Smith : Chapter 9): Rate equations for fluid - Solid Catalytic Reactions: Rates of adsorption, Desorption, Surface Reaction - Rate equations in terms of Fluid phase concentrations at the catalyst surface - Qualitative analysis of rate equation - Quantitative inter pretation of Kinetic data - Redox Rate equations.

Unit IV: (Scope : Octave Levenspiel : Chapter 15) : Deactivating Catalysts : Mechanism of Catalyst Deactivation - The ratre of equation - The rate of equation from experiment - Batch - solids: Determining the rate for Independent Deactivation Batch - solids : Determining the rate of parellel, series or side - by - side Deactivation - Flowing solids experimental Reactors - Finding the Mechanism of Decay from experiment Design.

Unit V: (Scope : J. M. Smith : Chapter 10) : External transport Processes in Heterogeneous Reactions: Fixed bed reactors - The effect of physical processes on observed rate of reaction - Mass and Heat transfer coefficients (fluid particle) in packed beds - Quantitative treatment of external transport effects - Stable operating conditions - Effect of external transport Processes on selectivity.

Fluidised bed reactors - Particle - fluid Mass and Heat transfer Slurry Reactors - Mass transfer coefficients: Gas bubble to liquid (K_1) - Mass transfer coefficients: Liquid to particle (K_c) - The effect of mass - transfer on observed rates Trickle - Bed reactors - mass transfer coefficients: Gas to liquid ($K_1 a_g$) - Liquid to particle ($k_c a_c$) - Calculation of global rate.

Text Books:

1. Smith. J.M., " Chemical Engineering Kinetics", McGraw Hill book Company, New Delhi (Third Edition) 1981.

2. Octave Levenspiel, " Chemical Reaction Engineering" , Wiley Eastern Limited - Second Edition - 1972.

Reference Books :

1. Thomas, J.M. And Thomas, W.J. " Introduction to the Principles of Heterogeneous Catalysis". Academic Press Inc., New York 1967.

2. Carbnerry, James, J., " Chemical and Catalytjic Reaction - Engineering", McGraw - Hill, Engineering Series.

IPCE 1.1.5: RESEARCH METHODOLOGY AND IPR

Common for M.Tech (Chemical, MPE, IPCE, CACE & Biotechnology)

Unit 1: Meaning of research problem, Sources of research problem, Criteria Characteristics of a good research problem, Errors in selecting a research problem, Scope and objectives of research problem. Approaches of investigation of solutions for research problem, data collection, analysis, interpretation, Necessary instrumentations

Unit 2: Effective literature studies approaches, analysis, Plagiarism, Research ethics,

Unit 3: Effective technical writing, how to write report, Paper, Developing a Research Proposal, Format of research proposal, a presentation and assessment by a review committee

Unit 4: Nature of Intellectual Property: Patents, Designs, Trade and Copyright. Process of Patenting and Development: technological research, innovation, patenting, development. International Scenario: International cooperation on Intellectual Property. Procedure for grants of patents, Patenting under PCT.

Unit 5: Patent Rights: Scope of Patent Rights. Licensing and transfer of technology. Patent information and databases. Geographical Indications.

Unit 6: New Developments in IPR: Administration of Patent System. New developments in IPR; IPR of Biological Systems, Computer Software etc. Traditional knowledge Case Studies, IPR and IITs.

References:

1. Stuart Melville and Wayne Goddard, "Research methodology: an introduction for science

2. & engineering students'"

3. Wayne Goddard and Stuart Melville, "Research Methodology: An Introduction"

4. Ranjit Kumar, 2nd Edition , "Research Methodology: A Step by Step Guide for beginners"

5. Halbert, "Resisting Intellectual Property", Taylor & Francis Ltd ,2007.

6. Mayall , "Industrial Design", McGraw Hill, 1992.

7. Niebel , "Product Design", McGraw Hill, 1974.

8. Asimov , “Introduction to Design”, Prentice Hall, 1962.

9. Robert P. Merges, Peter S. Menell, Mark A. Lemley, “ Intellectual Property in New

10. Technological Age”, 2016.

11. T. Ramappa, “Intellectual Property Rights Under WTO”, S. Chand, 2008

IPCE 1.1.6 A: Audit Course-1
(YOGA FOR WORKING PROFESSIONALS)
Common for M.Tech (Chemical, MPE, IPCE, CACE & Biotechnology)

Course objectives:

1. To make the student understand various practices of yoga and yoga diet.

2. To make the student be familiar with various asanas and other associated practices.

3. To make the student appraise the holistic benefits of yoga

4. To make the student identify a therapeutic solution for common health issues.

5. To make the student experience the pranahuti aided meditation.

Course outcomes:

1. The students will discover the importance of yoga for leading a disciplined way of life.

2. The students would improve their wellness by adapting various yogic practices in their day to day life.

3. The students would perceive the holistic benefits of yoga

4. The students can judge the causes of common diseases and can recommend therapeutic solutions based on yogic practices

5. The student can compare the placebo meditation and meditation with pranhuti.

Unit-I: Introduction to Yoga : The Origins of Yoga – Definitions - Concepts - Aims and objectives of Yoga - Yoga is a Science and Art - Ideal Practice of Yoga in the new millennium. Streams of Yoga - Karma Yoga - Bhakti Yoga - Jnana Yoga - Raja Yoga (Astanga Yoga) - Hatha Yoga - Yoga and Diet - - Yoga Disciplined way of life. Difference between Yogasanas and Physical Exercises.

Learning outcomes:

1. After completing this unit, the students will be able to recognize the differences between yogic practices and physical exercises.

2. At the end of this unit, the students will be able assess the relevance of yogic practices for holistic wellness in the contemporary times.

Unit-II: Yogasanas with practical : Loosening the joints- Joint freeing series, Suryanamaskar, Tadasana, Trikonasana, Artha chandrasana, Danurasana, Utkatasana, Dandasana, Pavanamuktasana, Hamsasana, Arthakati chakrasana, Artha chakrasana, Janusirasasana, Vajrasana, Makarasana, Padmasana, Sukhasana, Natrajasana, Savasana. Introduction to Kriyas, Pranayamas, Bandhas and Mudras.

Learning outcomes:

1. The students will be able to demonstrate some selective yogasanas.

2. The students will be able to appraise the importance of allied yogic practices such as pranayama, mudras, bandhas and kriyas.

Unit-III: Physiological benefits of Yoga : Physiological Benefits of Asanas and Pranayama – Chest Cage – Regulation of Breathing – Types of Breathing. Physiological Benefits of Bandhas – Mudras – Kriyas - Meditation – Nadis – Chakras – Kundalini shakti – Psycho-neuro Immunology. Role of Yoga on Psychological Qualities and Psychological Disorders.

Learning outcomes:

1. By studying this unit, the students will be able to value the physiological benefits of yoga practices.

2. The students will be able to support the role of yoga in the treatment of psychological disorders at the end of this chapter.

Unit-IV: Introduction to Yoga Therapy : Essence and Principles of Yoga therapy- Physiology and Pathology in the yoga – Shatra- koshas – doshas- Granthis – Pancha prana – Application of Yoga and its types- Methodology in Yoga Therapy – Factors (Heyam, Hetu, Hanam and Upayam) - Methods (Darsanam, Sparsanam, Prasnam, Nadi, Pariksa) Examination of Vertebra, joints, Muscles, Abdomen and Nervous system and therapeutic applications – Modification of yogic practices for Human Systems- Yogic diet.

Learning outcomes:

1. At the end of the unit, the students become familiar in assessing the health of an individual.

2. After completing this unit, the students can recommend appropriate yoga therapy for health problems faced by an individual.

Unit-V: Meditation : (The student has to maintain a diary to record his observations during meditation. This diary will help him to understand the extent of his progress)

Meaning and Concept of Meditation – Need of meditation- techniques of meditation-Tools of meditation-Advantages of Meditation- Experience of meditation- Obstacles. Sahaj Marg Meditation, Heartfulness movement.

Elements of sahaj marg meditation: Prayer, cleaning, sitting, satsang, universal prayer and suggestions. Ten maxims of sahaj marg.

Learning outcomes:

1. The student will be well versed in the benefits of meditation at the end of the unit.

2. The student can experience the difference in normal situation and meditative condition after experiencing pranahuti aided meditation.

Reference books

1. George Feuerstein: The Yoga Tradition (Its history, literature, philosophy and practice).

2. Georg Feuerstein. The Psychology of Yoga: Integrating Eastern and Western Approaches for Understanding the Mind.

3. Swamy Satyananda Saraswathi: Asana, Pranayama, Mudra, Bandha (India: Yoga Publications Trust, Munger, Bihar).

4. Swami Sivananda : Practice of Yoga (The Divine Life Society, Shivananda Nagar.P.O.,U.P. Himalayas, India).

5. Krishna Raman: A Matter of Health (Integration of Yoga and western medicine for prevention and cure) (Chennai East West Books(Madras) Pvt. Ltd.,1998.

6. Bhavanani, A.B. (2011): Application of Yoga Concept in the Health Improvement. In: P.Nikic, ed.

7. Ram Chandra, Complete works or Ram Chandra (Babuji) Vol. I, Sri Ram Chandra Misssion, SPHT, Calcutta.

IPCE 1.1.6 B- Audit Course -I Organizational Behavior

Common for M.Tech (Chemical, MPE, IPCE, CACE & Biotechnology)

UNIT-I: Organizational Behavior: Concept of Organization - Concept of Organizational Behavior - Nature of Organizational Behavior - Role of Organizational behavior - Disciplines contributing to Organizational Behavior.

UNIT-II: Motivation: Definition - Nature of Motivation - Role of Motivation - Theories of Motivation: Maslow's Need Hierarchy Theory, Herzberg's Motivation Hygiene Theory and McGregor's Theory X and Theory Y.

UNIT –III: Group Dynamics: Meaning - Concept of Group - Types of groups -Formal and Informal groups - Group development - Group cohesiveness and factors affecting group cohesiveness.

UNIT-IV: Leadership: Concept of Leadership - Difference between Leadership and Management - Importance of Leadership - Leadership styles: Autocratic leadership, Participative leadership and Free Rein leadership.

UNIT-V: Communication: Meaning - Communication Process - Forms of communication: Oral, Written and Non- Verbal communication - Direction of communication: Downward, Upward and Horizontal communication.

UNIT-VI: Organizational conflicts: Concept of conflict - Reasons for conflict - Types of Conflict: Intrapersonal conflict, Interpersonal conflict, Intragroup conflict, Intergroup conflict, Inter organizational conflict - Conflict management.

UNIT –VII: Organizational Change: Nature - Factors in Organizational change -Planned change: Process of planned change - Resistance to change: Factors in resistance to change - Overcoming resistance to change.

Text Books.

1.L.M.Prasad: Organizational Behavior, Sultan Chand & Sons, New Delhi -110002

2.K. Aswathappa: Organizational Behavior, Himalaya Publishing House, New Delhi

Reference Books.

1. Stephen Robbins: Organizational Behavior, Pearsons Education, New Delhi.

II SEMESTER

IPCE-1.2.1 : AIR POLLUTION CONTROL IN INDUSTRY

The objectives of this course are to provide the student with:

* a basic understanding of the fundamentals of air pollution with a background on historical perspective on air pollution

* knowledge of major air pollutants; their sources and effects (environmental, economic and health), Sampling of air pollutants and their analysis

* Insight into the dispersion of air pollution in the atmosphere

* knowledge of air pollution control equipment and their design aspects

* knowledge of various techniques to reduce the concentration of pollutants like sulphur dioxide, nitrogen oxide, organic vapors etc

* Knowledge of air pollution legislation and role of citizens in air pollution control

Outcome:

(a) Enables student to gain knowledge about the nature, origin of air pollution and impact of the air pollution on human beings, plants and materials

(b) Enables the student to learn the sampling and analysis of pollutants (Monitoring of air pollutants)

(c) Enables the student to understand the updated engineering technologies to control air pollution and air pollution legislation.

(d) Enables student to gain knowledge about various technologies available to control of specific air pollutants like So_2, No_x , organic vapors etc.

SYLLABUS

Sources, nature and type of pollutants, emission factors, meteorological factors in pollution, plume behavior and characteristics, chill index, equivalent ambient temperature, chimney design considerations, plume rise, effective stack height, element of air pollution modeling, acid rain problem,

Health effects of pollution, effect of plants, animals and materials, problems of air pollution in India, global problems, air pollution measurements, Ringleman's chart.,

Air pollution technology-I: Sampling and analysis of particulate matter and gaseous pollutants, removal of particulate matters, principles and design of settling chambers, solid traps, cyclone separators, fabric filters and fiber filters, scrubbers and electro-static precipitators,

Air pollution technology-II: General methods of control and removal of sulfur-dioxide, oxides of nitrogen and organic vapors from gaseous effluents, air pollution legislation, role of citizens in air pollution control,

Case Studies: Madhura refinery and it's impact on Taj Mahal, Bhopal gas tragedy, Chernobyl disaster and HPCL Visakha refinery, changes in raw materials, alternative technology for minimization of pollutants.

Reference books:

1. 'Design of Pollution Control Equipment' by Gregory Sincero and Adam Sincero

2. 'Air Pollution' by H.V.N. Rao, Mc Graw Hill Publications, 1998.

IPCE-1.2.2: Process Dynamics & Control
(Common for MPE, CACE & IPCE)

Objectives :

The main purpose of teaching Process Dynamics & Control for first year postgraduate students is to take the student from basic mathematics to a variety of design applications in a clear, concise manner. This course is focused on the use of the digital computer in complex problem solving and in process control instrumentation. For chemical engineering problem solving students need more advanced mathematical preparation like partial differential equations, linear algebra and Fourier series all are introduced in this course.

Outcome:

* Able to know the sampled data control systems consists of sampling and advanced mathematical model Z- transforms.

* Able to describe the process in which the flow of the signals is interrupted periodically like in chromatograph.

* Able to calculate the open loop response of a sampled data system and can develop a pulse transfer function that is the counterpart of the transfer function for continuous systems.

* Able to know the sophisticated instruments used for the analysis of water and air pollutants, The student should have knowledge to design the equipment used for the abatement of these pollutants.

* In a position to modernize the solid waste management and the student must be in a position to get awareness on accidents that are occurring in industries during handling, storage, and manufacturing of chemicals, remedial measures to arrest the accidents immediately.

SYLLABUS

Unit-1 : Review of time domain, Laplace domain and frequency domain dynamics of process and control system.

Learning outcomes

* Able to know the sampled data control systems consists of sampling and

* Able to solve the problems related to Laplace domain and frequency domain dynamics of process and control system.

Unit-2 : Sampled data control system – sampling and Z–Transforms , open loop and closed loop response, Stability.

Learning outcomes

* Able to solve the problems related toSampled data control system – sampling and Z–Transforms ,

* Able to calculate the open loop response of a sampled data system and stability

Unit-3 : State space methods – representation of physical systems – transfer function matrix – Multivariable systems – Analysis and control.

Learning outcomes

* Able to solve the problems related toState space methods – representation of physical systems and Student can develop a pulse transfer function that is the counterpart of the transfer function for continuous systems.

* Able to solve the Design Multivariable control systems – Analysis and control.The student should have knowledge to design the equipment used for the abatement of these process control systems.

Unit-4 : Non linear control –examples of non linear systems – Methods of phase plane analysis.

Learning outcomes

* Able to solve the problems related toNon linear control systems

* Able to solve the problems related toexamples of non linear systems and also develops Methods of phase plane analysis.

Unit-5 : Control of heat exchangers, distillation columns and Chemical Reactors.

Learning outcomes

* Able to solve the problems related toControl of heat exchangers, distillation columns and

* Able to solve the problems related toChemical Reactors.

Textbooks:

1. Process system Analysis and control, 2nd edition, Donald R Coughanower and Koppel.

2. Automatic process Control by Peter Harriot.

3. Process Modeling, Simulation and control for Chemical Engineers by W.L. Luyben.

IPCE-1.2.3 - ANALYTICAL TECHNIQUES

Objective:

To understand the different types of analysis methods used in chemical industries. The course consists of both chemical and instrumental methods and also both qualitative and quantitative methods of analysis. In this course, the chemical methods of quantitative analysis include all the aspects such as: selection and sampling of materials, preparation of solutions, and analysis of various chemical raw materials and products. In instrumental methods colorimetric, spectrophotometric, spectrographic, flame emission, photo meter have been discussed.

Outcome:

* The student should be able to know the theory of sampling, selection and preparation of the sample.

* The student should be able to know the sophisticated instruments used for the analysis of mineral ores and chemical samples. The student should have knowledge of analysis for the ores and chemical samples.

* The student should be in a position to understand the operation of instruments like X- Ray, flame emission spectroscopy.

* The student can determine the traces of elements in the metals and alloys required for specific application.

SYLLABUS

Unit-1 : Theory of sampling, sampling of ores, minerals and coals, proximate and ultimate analysis of coal; coking index, calorific value of coal, its determination and calculation, analysis of ash,

Learning outcomes

* The student should be able to know the theory of sampling

* Selection and preparation of the sample. And coal

Unit-2 : Wet assaying of ores of iron, copper, lead, zinc and manganese, dry assaying process, fire saving methods for gold and silver,

Learning outcomes

* The student should be able to know the theory of samplingWet assaying of ores of iron, copper, lead, zinc and manganese able to determine the metals and alloys required for specific application

* The student can determine the traces of elements and also The student should be able to know the theory of dry assaying process, fire saving methods for gold and silver,

Unit-3 : Instrumental methods of mineral investigation: Theory and techniques of colorimetry and absorptiometry, photometer, spectrophotometers, atomic absorption spectrophotometer,

Learning outcomes

* The student should be able to know the sophisticated instruments used for the analysis of mineral ores and chemical samples Theory and techniques of colorimetry

* The student should be able to know the sophisticated instruments used for the analysis of mineral ores and chemical samples Theory and techniques of photometer, spectrophotometers, atomic absorption spectrophotometer

Unit-4 : Electrochemical methods of analysis, Electrogravimetry methods, potentiometric titration, polarography, DTA,

Learning outcomes

* The student should be able to know the sophisticated instruments used for the analysis Electrochemical methods of analysis,

* The student should be able to know the sophisticated instruments used for the analysis Electrogravimetry methods, potentiometric titration, polarography. And The student should have knowledge of analysis for the ores and chemical samples.

Unit-5 : X-ray techniques, emission of X-rays, X-rays instrumentation, X-ray diffraction, flame emission spectroscope - source, equipment and application of emission spectroscopy.

Learning outcomes

* The student should be able to know the sophisticated instruments used for the analysis X-ray techniques, emission of X-rays, X-rays instrumentation, X-ray diffraction,

* The student should be able to know the sophisticated instruments used for the analysis flame emission spectroscope - source, equipment and application of emission spectroscopy

Reference books:

1. 'An Introduction to Metallurgical Analysis: Chemical & Instrumental' by S.K. Jain, Vikas Publishing House

2. A Text Book of Metallurgical Analysis' by B.C.Agarwal & S.P.Jain, Khanna Publications.

3. A Text Book of Quantitative Inorganic Analysis' by A.I.Vogel, ELBS Edition.

IPCE-1.2.4 - Elective-III

IPCE-1.2.4 A-ELECTIVE-III
(Industrial Hazards, Safety Measures & Environmental Impact Assessment)

Course objective:

This course is designed to promote the knowledge on various important aspects of hazard analysis and EIA techniques which are mandatory for implementation by the industries. The objective include an intention that the student will get fair opportunities for obtaining employment as this particular course is having lot of demand in India and abroad.

Course Outcome:

* Now a day's industrial & occupational safety gained paramount importance for loss prevention in order to achieve considerable profit in process industries. This course significantly help the students to learn the concepts of safety, hazards, risk, occupational safety management

* This course include an approach of conducting environmental impact assessment study and preparing reports which is mandatory for all the process industries being setup

* The course also describes various methodologies for identification and assessment of hazards involved in handling and processing of various harmful chemicals in industries

* Emergency preparedness plans are included in this course which enlighten the learners various aspects of planning, emergency resources, action teams and rescue operations in case of real emergencies in industries

* The students will be knowing various statutory regulations pertaining to factories act, environmental protection act, static and mobile pressure vessel rules and other regulatory amendments to comply which can help them when they are employed in industrial sectors

* This course may help the students for getting opportunities abroad because of huge demand of HSE engineers especially in gulf oil companies and basic chemicals manufacturing companies

* Further learning in this field may provide self employability by way of freelanced consultancy to the industries

* This course will provide the basis for taking up further research work in inventing new technologies for effective management of industrial hazards and occupational health

SYLLABUS

Unit - I : Introduction: Hazards – chemical hazards, thermodynamic hazards, electrical & electromagnetic hazards, mechanical hazards & health hazards, Risk – definition, causes, potential & adverse effects, statutory framework – key provisions of factories act, environmental protection act, manufacture, storage & import of hazardous chemical rules, static & mobile pressure vessels rules, NFPA specifications, OSHA regulations

Learning outcomes:

* The definitions like Hazard, Risk, Incident, Accident, Near-miss will give basic understanding about the terminology used in Industrial Safety

* Some of the key provisions of Factories Act, Environmental Protection Act, SMPV Rules, NFPC specifications, OSHA regulations will enhance the knowledge of various national & international standards

Unit – II : Hazard Analysis: Incident scenarios, residual risk, concept hazard analysis, preliminary process hazard analysis, HAZOP, Fault Tree Analysis (FTA), Event Tree Analysis (ETA), sneak analysis, Failure Mode and Effect Analysis (FMEA), Human Reliability Analysis (HRA), Cause Consequence Analysis (CCA)

Learning outcomes:

* The course also describes various methodologies for identification and assessment of hazards, involved in handling and process in of various harmful chemicals in industries

* The concepts like residual & societal risk will help the student to understand to implement acceptable risk methodologies in process operations

Unit – III : Safety Management Systems: Safety policy perceptions, safety organization, safety audit techniques, project and construction safety – welding and cutting operations, fabrication, material handling, equipment spacing, safe plant layout procedures, storage tanks, erection and commissioning works,

housekeeping methods, maintenance of storage yards, erection and maintenance of electrical panels and MCC rooms, electrical & mechanical safe guarding, process safety management – elements, methods of management, equipment reliability, preventive maintenance schedules, work permits, emergency preparedness – onsite & offsite emergency preparedness, emergency preparedness plans, site specific action plans & contingency plans, emergency facilities, rehabilitation & rescue operations, post emergency actions

Learning outcomes:

* The overview of BIS:14489 "Code of Conduct of Occupational Health & Safety Audit" will enhance the students capabilities in conducting safety audit for the hazardous industries

* Emergency preparedness plans are included in this course which enlighten the learners various aspects of planning, emergency resources, action teams and rescue operations in case of real emergencies in industries

Unit – IV : Occupational Safety Management: Occupational health perspectives, pre-employment & periodical medical examinations, diseases, causes, consequences, occupational health hazards in various industries – aluminium industry, asbestos, battery manufacturing, sugar, cement, coke ovens, cotton ginning, dairy, electro plating, fish canning, poultries, irrigation, lead smelting, mining, pesticides, power plants, refineries, pulp & paper industry, PVC processing, steel plants, fertilizers, sulphuric acid plants, tanneries & textiles

Learning outcomes:

* Elaborate discussions on various factors contributing towards occupational health issues of the workers in industries will enlighten the student to understand causative factors and its mitigation at source level

* The occupational health programs to associated with various types of industries include battery manufacturing, electro-plating, lead smelting, refineries, pulp & paper industry, etc will be well-known to the student and gives scope to find out innovative solutions

Unit – V : Environmental Impact Assessment: Introduction, comprehensive of EIA, methodology, framework of EIA, considerations, application, purpose of EIA, rapid EIA, baseline data collection – air pollution parameters, water pollution parameters, soil pollution, noise pollution, meteorological parameters, socio-economic studies, prediction and assessment of impacts on air environment, water environment, ecological factors, meteorological factors, flora & fauna and socio-economic conditions, environmental matrices, quantitative assessment of adverse effects, preparation of environmental management plan – considerations, study observations, process modifications, emission control, development of greenbelt, ecological restoration, soil conservation, rainwater harvesting, recharge of groundwater table, restoration of flora & fauna, reclamation, rehabilitation, conservation of historical monuments, review of EIA plans, modifications, environmental impact assessment for major industries – steel plants, refineries, power plants, bulk drugs, tanneries, mining, fertilizers and chemical industries.

Learning outcomes:

* The Environmental Impact Assessment studies are mandatory for all industries for obtaining Environmental clearance from the statutory authorities. The student will learn various steps involved in conducting a systematic Environmental Impact Assessment by considering various impacts on environmental parameters like Air, Water, Land, Meteorological, Noise, etc.

* After completion of the course, the student is expected to be in a position to evaluate appropriate environmental management plans to prevent or mitigate various adverse impacts of the industrial activities on environment

Text Books:

1. "Hazard identification and risk assessment" by Geoff Wells, Institution of Chemical Engineers, Davis Building, UK

2. "Occupational health and safety guidelines" by Environmental Department, The World Bank, Washington DC

3. "Environmental Impact Assessment" by Larry W.Canter

CHEM-1.2.4 B – ELECTIVE-III (Petroleum Refinery Engg-II)

Objective: The objective of this course is to provide with the:

* Production process for the manufacture of C1 to Aromatic Compounds.

* Design aspects for designing of various equipment used in the process.

Outcomes: The student will be able to:

* Understand the process and mechanism of various production process of C1 to Aromatic compounds.

* Design various equipment used in the production process.

SYLLABUS

Petrochemical industry in India, Raw materials for petrochemicals, refinery process for petrochemical feed stocks, pyrolysis for petrochemical feed stocks, separation of hydrocarbons.

Learning outcomes:

* Choose various petrochemical feed stocks for manufacture of petrochemical compounds.

* Discuss various refining process for the manufacture of petrochemical feed stocks.

Petrochemicals from C1 fractions: Synthesis gas, Methanol, Formaldehyde, Chloromethanes, Hydrogen cyanide, Methyl amines.

Petrochemicals from C2 fractions: Polyethylene, Ethanol, Ethylene Oxide, Acetaldehyde, Ethyl Benzene, 1-2 dichloroethane, Vinylchloride, Vinylacetate, Ethanol amines.

Learning outcomes:

* Design and evaluate a process for the manufacture of C_1 fractions.

* Design and evaluate a process for the manufacture of C_2 fractions.

Petrochemicals from C3 fractions: Isopropanol, Acetone, Propylene oxide, Acrylonitrile, Cumene, Isoprene, Oligomers and co-oligomers of Propylene.

Petrochemicals from C4 fractions: Butadiene, Diisobutene, Butanol, Methacrylic acid, Maleic anhydride.

Learning outcomes:

* Design and evaluate a process for the manufacture of C_3 fractions.

* Design and evaluate a process for the manufacture of C_4 compounds.

Petrochemicals from Aromatic compounds: Production and separation of aromatics, Aniline, Phenol, Maleic anhydride, Toluene diisocynate, Phthalic anhydride, Dimethyl terephthalate.

Learning outcomes:

Design a process for the production of aromatics.

Develop a process for the separation of aromatics.

Design of petrochemical equipment: Pyrolysis furnace, pyrolysis reactor, super fractionator, fixed bed reactor, multiphase reactor.

Learning outcomes:

Design of pyrolysis furnace, pyrolysis reactor and super fractinator.

Design of fixed bed reactor, multiphase reactor.

Text Books :

1. Ethylene & its derivations - S.A. Miller
2. Propylene and its derivations - E.G. Hancock.
3. Benzene, Toluene, Xylene and their Derivations. E.G. Hancock.
4. Petrochemicals by B.K.Bhaskara Rao.

IPCE-1.2.4 C- ELECTIVE-III (Electro Chemical Engineering-II)

Objectives: The main objectives are to provide

1. Knowledge on Electroplating, Electroforming, electro refining, electro wining.
2. Knowledge on Electrolysis and Manufacturing process.
3. Knowledge on primary & secondary batteries and fuel

Outcome: At the end of the course, the student will be able to

1. Explain different electrochemical ore beneficiation techniques, electroplating, electro refining and electro winning.
2. Take part in commercial and industrial manufacturing units using electrolysis.
3. Design, test and evaluate batteries e.g. Primary and secondary batteries, charge/discharge cycles, overpotential, battery capacity, state of charge, state of health, impedance.
4. Construct, Compare and test Fuel cells.

SYLLABUS

Part –A

Electroplating, Electroforming and Electrophoresis

Electrorefining of metals - Copper, Silver, Gold, Nickel, Lead and Cobalt.

Electrowinning of metals - Copper, Zinc, Cadmium, Chromium and Manganese.

LO1: Appraise various metal extraction procedure by electrochemical means

LO2: Recommend the process conditions

Electrolysis of Alkali Halides and Sulfates - Chlorine and Caustic, Potassium halides, Hydrochloric acid, Fluorine and sodium sulfate. Manufacture of Hydrogen and Oxygen. Electrolytic Reduction and Oxidation - Persalts, Cuprous oxide, Mercuric oxide, Manganese dioxide and Perchlorates. Electrolysis of fused Salts - Aluminum, Magnesium, Sodium, Beryllium and Zirconium.

LO3: Choose appropriate manufacturing processes of ionic salts by electrochemical schemes

LO4: Compare different sets of conditions for the manufacture of a given salts

Part –B

Batteries: Classification of cells and batteries, theoretical cell voltage, capacity, energy, electrochemical principles and reactions

Primary batteries: Zinc carbon batteries (Leclanche and Zinc chloride cell system), Magnesium and Aluminum batteries, Alkaline manganese dioxide batteries, Lithium batteries.

Secondary batteries: Lead acid batteries, nickel cadmium batteries, nickel metal hydride batteries, lithium ion batteries, rechargeable zinc, alkaline, manganese dioxide batteries

LO5: Evaluate the working behavior of different batteries

LO6: Estimate the charge discharge characteristics of a battery

Fuel cells: Molten carbonate fuel cell(MCFC), phosphoric acid fuel cell(PAFC), Solid oxide fuel cell (SOFC), proton exchange membrane fuel cell(PEMFC).

LO7: Assess the working of different Fuel cells

LO8: Construct and test of Fuel Cell

Textbooks:

1. Electrochemical Engineering by Mantell, C.L. McGraw–Hill

2. Electrochemistry Principles and Applications Edmund Potter, Cleaver–Hume Press Ltd.

3. Handbook of batteries by David linden and Thomas B Reddy, McGraw –Hill

IPCE-1.2.5- ELECTIVE-IV

IPCE-1.2.5 A-ELECTIVE-IV (Corrosion Engineering-II)

Common for M.Tech (Chemical, MPE, IPCE, CACE & Biotechnology)

Objectives:

* To enable the principles of corrosion, common corrosion forms, uniform, galvanic, pitting, inter granular, crevice, dezincification, stress corrosion, corrosion fatigue, hydrogen embrittlement corrosion control methods, and material selection to reduce corrosion cost.

* To enable the ability to understand electrochemical fundamentals

* To enable the ability to understand corrosion preventing methods

Outcome:

* The student would know application of weight loss method

* The student would know application of cathodic protection, anodic ptotection

* At the end of this course, the student would know effective surface preparation of specimen can be done

* After completion of this course, the student would understand the causes and the mechanisms of various types of corrosion, including uniform corrosion, galvanic corrosion, crevice corrosion, pitting corrosion, intergranular corrosion.

* The student would know application of Corrosion Processes and Evans Diagrams and application of electroplating, coatings and importance of inhibitors.

SYLLABUS

Corrosion in selective environments: Marine, Acids (Sulfuric acid, Hydrochloric acid, Nitirc acid, Phosphoric acid) Biological and industrial gases ($SO_2$$H_2S$).

* Able to understand corrosion and its mechanism in marine atmosphere.

* Able to understand corrosion in acidic media like Sulfuric acid, Hydrochloric,etc.

Corrosion Testing - Purposes, Materials and specimen. Surface preparation, Measuring and weighing , Exposure Techniques - duration, Planned - Interval Tests, Aeration, cleaning specimens after exposure, Temperature, Standard expression for corrosion rates - Galvanic Corrosion, Erosion Corrosion, crevice Corrosion, Intergranular corrosion, test for stainless steels, warren test pitting, stress corrosion, Paint tests, Sea Water tests, Presenting and summarizing data - Nomo graph for corrosion rates and interpretation of results.

* Able to understand the importance of surface preparation.

* Able to understand the application of Standard expression for corrosion rates using weight loss method.

* Able to understand the application of different corrosion tests.

Cathodic and anodic protection, surface preparation for coatings and chemical conversions: Degreasing, Descaling , Polishing - Anodized coating : anodizing oxidizing, chromate coating, phosphate coatings - Metallic coatings : Hot dipping, cementation, vapor deposition of metallic coating; Sprayed coatings: flame spraying plasma spraying, Galvanizing - Electroplating : Nickel & chromium coatings, chromizing.- Organic coatings : paints, enamels, lacquers, resin mixtures.

* Able to understand the application of Cathodic and anodic protection.

* Able to understand the uses of Degreasing, Descaling , Polishing.

* Able to understand the importance of Hot dipping, cementation, vapor deposition of metallic coating. Linings, laminates, reinforced plastic, fibre glass - Corrosion inhibitors: mechanism of inhibition, recirculating of water of water systems.

* Able to understand the importance of Corrosion inhibitors and mechanism of inhibition.

Measurement and testing of preventive coatings ; Thickness and Resistance tests for anodized, Painted, electroplated surfaces using polarization resistance, Linear polarization, curve fit analysis and Electrochemical impedance spectroscopy.

* Able to understand the Thickness and Resistance tests.

* Able to understand the linear polarization and curve fit analysis.

Reference books :

1. Mars G.Fontana - Corrosion Engineering

2. Burns, R.M., Bradley, W.W., ‘protective coatings for Metals.’ Chapters 2 to 18.

Reference Books :

Corrrosion Volumes 1 & 2 by L.L. Shrier, Newnes - Butter-worths, London.

IPCE- 1.2.5 B - Elective-IV (Energy Engineering-II)

Common for M.Tech (Chemical, MPE, IPCE, CACE & Biotechnology)

Course objectives:

1. The student is provided with the fundamentals of renewable energy processes.

2. Basic information to comprehend the various non-conventional energy systems would be illustrated to the student.

3. Various ways of obtaining energy from ocean can be demonstrated to the student.

4. The methods of energy conservation and the opportunities for conservation would be emphasized.

5. Economics involved in the energy production processes would be enumerated to the student.

Course Outcomes:

1. Methods to be adopted to utilize biomass as an important energy source

2. Application of thermodynamics to obtain energy from various sources

3. Possible mechanism to draw energy from wind and other natural resources

4. Knowledge about energy conservation and storage

5. Emerging technologies to produce energy such as thermionics, thermoelectricity etc.

SYLLABUS

Fundamentals of energy science and technology: Introduction – Energy, economy and social development – Oil crisis of 1973 – classification of energy sources – consumption trend of primary energy resources – importance of non-conventional energy sources – energy chain – common forms of energy – advantages and disadvantages of conventional energy sources – salient features of non-conventional energy sources – energy densities of various fuels – environmental aspects of energy – The United Nations Framework Convention on Climate Change – Energy-environment-economy – World energy status – energy scenario in India. Energy conservation and efficiency: Introduction – important terms and definitions – important aspects of energy conservation – global efforts, achievements and future planning – energy conservation/efficiency scenario in India – energy audit – energy conservation opportunities – cogeneration – combined cycle plants. Energy storage: Introduction – necessity of energy storage – specifications of energy storage devices – energy storage methods.

Learning outcomes:

1. The student can identify the ways and means of conservation of energy once the student completes learning this unit.

2. The student can appraise the necessity of energy storage and recommend the methods for energy storage at the end of the unit.

Wind energy: Introduction – origin of winds – nature of winds – wind turbine siting – major applications of wind power – basics of fluid mechanics – wind turbine aerodynamics – wind turbine types and their construction – wind energy conversion systems – wind-diesel hybrid system – effects of wind speed and grid condition – wind energy storage – environmental aspects – wind energy program in India.

Learning outcomes:

1. By studying this unit, the students will be able to predict where the wind power plants can be located.

2. At the end of this unit, the students can recommend appropriate technology for obtaining geothermal energy in a given situation.

Biomass: Introduction – Photosynthesis process – usable forms of biomass, their composition and fuel properties – biomass resources – biomass conversion technologies – urban waste to energy conversion – biomass gasification – biomass liquefaction – biomass to ethanol production – biogas production from waste biomass – energy farming. Geothermal energy: Introduction – applications – origin and distribution of geothermal energy – types of geothermal resources – analysis of geothermal resources – exploration and development of geothermal resources – environmental considerations – geothermal energy in India.

Learning outcomes:

1. After completing this unit, the students will be able to choose appropriate biogas plant for a given location and able to provide dimensions of the same.

2. At the end of this unit, the students will be able to recommend a process for utilizing the biomass for a given application.

Ocean Energy: Introduction: Tidal energy – wave energy – ocean thermal energy. Small hydro resources: Introduction – advantages and disadvantages of small hydro schemes – layout of a micro-hydroscheme - water turbines – turbine classification, characteristics and selection – generators – present status.

Learning outcomes:

1. At the end of this unit, the students can recommend appropriate technology for obtaining energy from ocean in a given situation.

2. Suitable scheme for generating electricity from small hydroresources can be suggested by the student after the completion of this unit.

Emerging technologies: Introduction – fuel cell – hydrogen as energy carrier. Miscellaneous non-conventional energy technologies: Introduction – magneto hydrodynamic power conversion – thermoelectric power generation – thermionic power conversion. Financial and economic evaluation: Introduction – basic terms and definitions – calculations for the case of single payment – calculation for uniform series of payments – calculations for uniform gradient series of payments – calculations for geometric gradient series of payments – effect of inflation on cash flows – comparative economic evaluation of alternatives – effect of depreciation and tax on cash flow.

Learning outcomes:

1. New technologies for obtaining energy from various renewable sources can be evaluated by the student.

2. Economic factor in the energy production by various technologies can be compared by the student at the end of this unit.

Text book:

Non-Conventional Energy Resources by B.H. Khan, 3/e, McGraw Hill (2017).

Reference book:

Fundamentals of Renewable Energy Processes by Aldo V. Da Rosa. Elsevier (2005).

IPCE- 1.2.5 C - Elective-IV (Reaction Engineering-II)

Common for M.Tech (Chemical, MPE, IPCE, CACE & Biotechnology)

SYLLABUS

UNIT - I : Laboratory Reactors - Interpretation of Experimental Data - Interpretation of Laboratory Kinetics Data - Homogeneous and Heterogeneous Laboratory Reactors. Calculation of Global Rate - The structure of Reactor Design. (Scope: Chapter 12 of J.M Smith 3rd Edition)

UNIT - II : Design of Heterogeneous Catalytic Reactors Isothermal and Adiabatic Fixed Bed Reactors Non-isothermal, Non-adiabatic Fixed Bed Reactors. (Scope: Chapters 13.1 - 13.9 of J.M Smith 3rd Edition)

UNIT - III : Design of fluidized bed Reactors - Two -Phase Fluidized Bed model - Operating characteristics - Slurry Reactors - Trickle - Bed Reactors - Optimization. (Scope: Chapter 13.10 - 13.13 of J.M Smith 3rd Edition.)

UNIT - IV : Fluid - Solid Noncatalytic Reactions - Design concepts - Single Particle Behavior - Reactor Models. (Scope: Chapter 14 of J.M Smith 3rd Edition)

UNIT - V : Short notes from the portions of all the above four units. Four bits are to be answered out of 7 bits (Not more than 2 bits to be given from any one Unit).

Text Book:

Chemical Engineering Kinetics by J.M Smith, McGraw - Hill Book Company , 1980, 3rd Edition.

IPCE 1.2.6: AUDIT COURSE -2

IPCE 1.2.6 A : DISASTER MANAGEMENT (Audit Course -2)

Common for M.Tech (Chemical, MPE, CACE, IPCE, Biotechnology)

Introduction to Disaster: Definition, Factors And Significance; Difference Between Hazard And Disaster; Natural And Manmade Disasters: Difference, Nature, Types and Magnitude. Repercussions Of Disasters And Hazards: Economic Damage, Loss of Human And Animal Life, Destruction Of Ecosystem. Natural Disasters: Earthquakes, Volcanisms, Cyclones, Tsunamis, Floods, Droughts And Famines, Landslides And Avalanches, Man-made disaster: Nuclear Reactor Meltdown, Industrial Accidents, Oil Slicks And Spills, Outbreaks Of Disease And Epidemics, War And Conflicts.

Disaster Prone Areas in India Study Of Seismic Zones; Areas Prone To Floods And Droughts, Landslides And Avalanches; Areas Prone To Cyclonic And Coastal Hazards With Special Reference To Tsunami; Post-Disaster Diseases And Epidemics

Disaster Preparedness And Management Preparedness: Monitoring Of Phenomena Triggering A Disaster Or Hazard; Evaluation Of Risk: Application Of Remote Sensing, Data From Meteorological and Other Agencies, Media Reports: Governmental And Community Preparedness.

Risk Assessment Disaster Risk: Concept and Elements, Disaster Risk Reduction, Global and National Disaster Risk Situation. Techniques of Risk Assessment, Global Co-Operation In Risk Assessment and Warning, People's Participation In Risk Assessment. Strategies for Survival

Disaster Mitigation Meaning, Concept and Strategies Of Disaster Mitigation, Emerging Trends In Mitigation. Structural Mitigation And Non-Structural Mitigation, Programs Of Disaster Mitigation In India.

REFERENCES:

1. R. Nishith, Singh AK, "Disaster Management in India: Perspectives, issues and strategies "'New Royal book Company.

2. Sahni, PardeepEt.Al. (Eds.)," Disaster Mitigation Experiences and Reflections", Prentice Hall Of India, New Delhi.

3. Goel S. L., Disaster Administration And Management Text And Case Studies", Deep & Deep Publication Pvt. Ltd., New Delhi.

IPCE 1.2.6 B: ENTREPRENEURSHIP (Audit Course -2)

Common for M.Tech (Chemical, MPE, CACE, IPCE, Biotechnology)

Unit -I : Basic Concepts of Management:Management :- Definition, Nature and Importance ; Functions of the Management; Levels of Management; F.W Taylor's Scientific Management; Henry Fayol's Principles of Management.

Unit-II : Forms of Business Organizations: Introduction, Types of Business organizations: Private Sector- Individual Ownership , Partnership, Joint stock companies and Co-Operative organizations; Public sector- Departmental Organizations, Public Corporations and Government Companies; The Joint sector Management.

Unit-III Production and operations Management: Plant location- Factors to be considered in the selection of Plant location; Break - even analysis-Significance and managerial applications; Importance of Production Planning and Control and its Functions; Human Resource Management and Functions of Human Resource Manager (in brief); Functions of Marketing; Methods of Raising Finance.

Unit-IV : Entrepreneurship: Definition, Characteristics and Skills, Types of Entrepreneurs, Entrepreneur vs. Professional Managers, Growth of Entrepreneurs, Nature and Importance of Entrepreneurs, Women Entrepreneurs, Problems of Entrepreneurship.

Unit-V : Entrepreneurial Development and Project Management: Institutions in aid of Entrepreneurship Development, Idea generation: Sources and Techniques; Stages in Project formulation; Steps for starting a small enterprise - Incentives for Small Scale Industries by Government.

Text Books:

1. Sharma, S.C, and Banga, T.R., Industrial Organization & Engineering Economics, Khanna Publishers, Delhi, 2000.

2. Vasant Desai, The Dynamics of Entrepreneurial Development and Management (Planning for future Sustainable growth), HImalayan Publishing House, 2018.

Reference Books:

1. Aryasri, A.R., Management Science, McGraw HIll Education (India Private Limited, New Delhi 2014.

2. Sheela, P. and Jagadeswara Rao, K., Entrepreneurship, Shree Publishing House, Guntur,

III SEMESTER

IPCE-2.1.1: Elective –V

IPCE-2.1.1 A- Elective –V (Environmental Biotechnology)

(Common with Biotechnology)

Objectives:

* Student to learn and understand environmental problems locally as well as global issue and consequencies.

* To learn about xenobiotics and their effect on ecosystem. To learn about biodiversity available.

* To learn about alternative and noval methods like biosorption of metals and bioleaching.

Outcome:

* Students have enough skills to identify the environmental problems and control measures.

* Students are in a position to plan to treat various industrial effluent using biotechnological methods

SYLLABUS

Unit-1 Ecosystem : Environment, types of Environment, Environment and Development, Environmental management, environmental education, principles of ecology, ecosystems, types of ecosystems, ecosystem structure and functioning, food chains, food webs, Ecological pyramids, nutrient cycling, microbial associations.

Learning Outcomes:

On completion of this topic, the student will be able to

i. Understand various types of ecosystems, association of components of ecosystems ii. Have an idea about food chains, food webs, ecological pyramids etc.

Unit-2 Pollution control : Source, effects and control aspects of various pollutants: Air (Particulate matter, SOx, NOx, COx, CHx, noise), water (primary, secondary and advanced treatment techniques), solids (recycling, incineration and bioconversion) Global environmental problems: global warming, ozone depletion and acid rain. Industrial effluent treatment: case studies of paper and pulp, tannery, pharmaceutical, fertilizer and petroleum industries.

Learning Outcomes:

On completion of this topic, the student will be able to

i. Have an ability to discuss various types of pollution & its control. ii. Identify Global environmental problems and treatment if necessary.

Unit-3 Biological Activities in the Environment : Biodegradation of Xenobiotics: Xenobiotic compounds in the environment, persistent compounds, degradation mechanisms.

Bioremediation: Bioremediation by microorganisms, bioremediation process and technologies, measuring bioremediation in the field, monitoring and efficacy of bioremediation.

Biosorption of metals: Microorganisms and metal absorption, factors affecting bioabsorption, bioreactors and bioabsorption, phytoremediation.

Bioleaching: Types of bioleaching, advantages and disadvantages of bioleaching, methods for bioleaching.

Learning Outcomes:

On completion of this topic, the student will be able to

i. Understand various biological activities like biodegradation, bioleaching, biosorbtion of metals, bioremediation etc, occurring in the Environment. ii. advantaged & disadvantages of above biological activities.

Unit-4 Biodiversity: Levels of biodiversity, value of biodiversity, global biodiversity, hotspots of biodiversity, threats to biodiversity, conservation of biodiversity.

Learning Outcomes:

On completion of this topic, the student will be able to

i. Have an idea of Biodiversity, its value & levels. ii. Understand threats & hotspots and conservation of biodiversity.

Unit-5 Environment and energy: Biomass sources, biomass production and utilization for energy, biomass conversation routes, energy crops, biofuels, biodiesel, hydrogen Production, conservation of energy. Biofertilizers, biopesticides, biofilters, biosensors, biopolymers and bioplastics.

Learning Outcomes:

On completion of this topic, the student will be able to

i. Have an ability to understand Environment & its energy conservation. ii. To identify & utilize biofertilizers, biopesticides, biosensors, biofilters, biopolymers & bioplastics, etc

TEXT BOOKS:

1. Environmental Pollution Control Engineering by C. S. Rao. Wiley Eastern Limited

2. Waste Water Treatment: Rational Methods of design and industrial practices by M. Narayana Rao and Amal K. Datta. Oxford & IBH publishing Co. Pvt. Ltd.

3. Environmental Biotechnology: Basic concepts and applications by Indu Shekhar Thakur. 1. K. International Pvt. Ltd.

REFERNCE BOOKS:

1. Microbial Ecology: A conceptional approach by Lunch, 1. M. Oxford Black N.S.D.

2. Environmental Biotechnology by Geetha Bali. APH Publishing Corporation.

IPCE-2.1.1 B- Elective –V (Waste to Energy)

Introduction to energy from waste: characterisation and classification of waste as fuel – agrobased, forest residues, industrial waste, Municipal solid waste.

Waste to energy options: combustion (unprocessed and processed fuel), gasification, anaerobic digestion, fermentation, pyrolysis.

Conversion devices: combustors (Spreader Stokes, Moving grate type, fluidized bed), gasifier, digesters.

Briqueting technology: Production of RDF and briquetted fuel. Properties of fuels derived from waste to energy technology: Producer gas, Biogas, Ethanol and Briquettes,

Comparison of properties with conventional fuels. Power generation using waste to energy technologies: Cl and Sl engines.

IGCC and IPCC concepts. Landfills: Gas generation and collection in land fills, Introduction to transfer stations.

Comparison with non-energy options like Vermiculture, Composting.

TEXT BOOKS

1. M.M. EL-Halwagi, Biogas Technology- Transfer and diffusion, Elsevier Applied science Publisher, New York, 1984.

2. D.O Hall and R.P. Overeed, Biomass – regenerable energy, John Willy and Sons Ltd. New York. 1987.

IPCE-2.1.1 C : Elective-V (Process Modeling and Simulation)
Common for M.Tech (Chemical, MPE, CACE & IPCE)

Objective:

Deals with writing various process models based on basic physical process. It also deals with solving the various models by means of numerical methods by computer simulation. By studying this course, one can simulate various chemical processes by computer simulation.

Outcome:

1. Understand the writing of a model of a process based on basic physical processes like mass, momentum and energy balances.

2. Able to develop a model equation for Tanks, Isothermal and Non-

Isothermal Systems

3. Able to understand the models for binary distillation column, batch reactors, etc.

4. Able to solve the model equations by numerical methods.

SYLLABUS

Principles of formulation - Continuity equations – Energy equation – Equation of motion – Equations of state – Transport equations – Chemical Kinetics – Algebraic and Integral / differential equations, Explicit and Implicit equations –Numerical Integration,Feed forward and feed backward control.

Basic modeling for tank system, mixing vessel – Simultaneous mass and energy balances – Models for boiling, batch distillation, and partial condenser. Models for Reactor – Model for heterogeneous catalysis – Models for pumping system – Model for heat exchanger.

Operational blocks in simulation- Simulation Programming – Simulation examples of three CSTR's in series, gravity flow tank, binary distillation column, non–isothermal CSTR.

Implicit function convergence ,Internal–halving convergence, Newton–Raphson method, False position convergence, Explicit convergence methods, Numerical Integration, Euler Integration, Runge - Kutta (fourth order) method.

Textbooks:

1. Process Modeling, Simulation and Control for Chemical Engineers by Luyben, W.L., McGraw Hill Books Co.

2. Mathematical Modeling in Chemical Engineering by Roger, G.E. Franks – John Wiley Sons Inc.

Reference Book:

Mathematical Methods in Chemical Engineering by V.G. Jenson and G.V. Jefferys, Academic Press – 2nd Edition.

IPCE-2.1.2: Elective –VI (Open Elective)

IPCE-2.1.2 A : Elective-VI (Nanotechnology)

Common for M.Tech (Chemical, MPE, CACE, IPCE, Biotechnology)

Objectives:

Nanotechnology may be treated as Green technology. It is one of the most advanced technologies now-a-days. It leads to have revolutionary changes in the fields of medical, Bio-medical, and fabrication of materials. Technologists are able to prepare ageless materials with the help of nano-techniques. Main objectives of the subject nanotechnology are :

1. To define green technology properly

2. To expose the students with new techniques of the nanotechnology.

3. To make them to learn the importance of quantum technology

4. To learn the procedure ageless materials to avoid wear-tear.

5. To learn the importance of nano –robots, machines

6. To know about the latest microscopes such as SEM, TEM

7. To know the importance of nanotechnology in the dawn of optical instruments

Outcome:

1. Application of nanotechnology in the development of energy

2. Application of nanotechnology in the development of solar panels, Fuel cells

3. Knew the importance of atoms manipulation

4. Knew that the applications of nanoparticles in the development of DVD, LEDs etc.

5. Biomedical applications in terms of preparing artificial, drug delivery, encapsulation, addition to that pharmaceuticals.

SYLLABUS

1. Introduction to nanotechnology, molecular and atomic size, surface and dimensional spaces. Molecular nanotechnology: atoms by inference, electron microscopes, nanomanipulator, nanotweezers, atom manipulation, nanodots, nanolithography.

Learning Outcomes:

* Define the term nanotechnology to understand in a better way the subject basics

* Demonstrate the different types of Electron Microscopes and their uses.

2. Nanopowders and nanomaterials: preparation, plasma arcing, chemical vapor deposition, sol-gels, electrodeposition, Ball milling, applications. Carbon nanotubes: types, formation, assemblies, purification, properties and uses.

Learning Outcomes:

* Summarize the nanomaterials used for the preparation of nanopowders

* Apply and selection of the different methods to prepare nanopowders

* Classify the carbon nanotubes and purification process.

3. Molecular mimics: Catenanes and rotaxanes, various molecular switches, synthesis of rotaxanes and catenanes, molecular computers, chemical rotors, prodders, flippers, atom shuttles, actuators, contacts.

Learning Outcomes:

* Categorize the molecular switches and synthesis of rotaxane and catenanes

* Examine the function of molecular computers

4. Nanobiometrics: Lipids as nano-bricks and mortar, self – assembled monolayers, proteins, 3-D structures arising from amines acids, nanoscale motors, Biological Computing, ion channels as sensors, Information in DNA structure, using DNA to build nano-cubes, hinges, smart glue, wire template.

Learning Outcomes:

* Evaluate the importance of nanobiometrics as self-assembled monolayers and nanoscale motors.

* Explain the process of biological computing and using DNA as hinges, smart glue, wire template

5. Optics, photomics and solar energy: Properties of light and nanotechnology, Interaction of light and nanotechnology, Nanoholes and photons, Imaging, New low cost energy efficient windows and solar absorbers based on nanoparticles, Photonic crystals, surface wave guides and control of light paths.

Learning Outcomes:

* Discuss about the optics, photomics and solar energy with reference to light properties.

* Chose a technique using nanoparticles to manufacture solar absorber, photonic crystals and change the light path.

6. Nanoelectrons: birth of electrons, semiconductors, transistor, integrated circuits, the tools of micro and nanofabrication, quantum electronic devices, quantum information and quantum computers, experimental implementations of quantum computers.

Learning Outcomes:

* Appraise different phased in the development of nanoelectornics tools.

* Construction of quantum computers and its experimental implementations.

7. Future applications: microelectomechanical systems, nano-robots , ageless materials, invisible mending of atomic dislocations inside damaged materials, nanomechanics and nanoelasticity, nanoparticle coatings, nanoelectronic and magnetic devices and new computing systems, optoelectronic devices, environmental applications.

Learning Outcomes:

* Assess the future application of nanotechnology in various fields

* Create new tools with nanotechnology to prepare new devices

Text-book:

1. M.Wilson, K.Kannangara, G. Smith, M. Simmons and B. Ragues, Nanotechnology, Overseas press (India) Private Ltd; New Delhi, 2005.

Reference books:

1. G. Ali Mansoori*, Principles of Nanotechnology, World Scientific Publishing Company, 2005.

2. G. Timp, Nanotechnology, Springer-Verlag, Network, 1999.

3. P. Poole and F.J. Owens, Introduction to Nanotechnology, John Wiley, 2003.

4. D.Ratner and M.Ratner, Nanotechnology: A Gentle Introduction, Pearson Education,2003.

5. B. Bhusan, Handbook of Nanotechnology, Springer, 2004

IPCE-2.1.2 B: Elective-VI (POLLUTION CONTROL)

Common for M.Tech (Chemical, MPE, CACE, IPCE, Biotechnology)

Objectives:

* Focus on classification of air pollutants, water pollutants and solid waste –causes, effects and control methods, need of environmental Legislation.

Outcome:

* Enables the students to adopt the preventive measures for the control of air pollutants, waste water treatment methods, and solid waste management methods in domestic, municipal waste.

* Enables the students to understand the control measures of pollutants emitted from different industries like Paper and pulp, fertilizer, sugar and alcohol, petrochemical and petroleum refinery, pharmaceutical and metal finishing industries.

SYLLABUS

Kinds of ecology, environment and ecofactors, types of ecosystems, sulphur cycles, phosphorous cycle, Nitrogen cycle and hydrological cycle Sources for water, Air and solid pollution, Analysis and effects of the pollutants in air, in water, Solids(particulate matter, SOx, NOx, Cox, CHx). Limits of pollutants, Environmental Legislation.

Control aspects of various pollutants Air (Particulate matter, SOx, NOx, COx, CHx, Noise) water (primary, secondary and territory treatment techniques) Solids (recycling, incineration,bio-conversion).

Case studies of Industries: Paper and pulp, petrochemical, Fertilizer, Pharmaceuticals, tannery, sugar and alcohol industries, metal finishing industries.

Learning Outcomes:

* Describe different ecosystems

* Explains the bio-geochemical cycles

* classify the main types of pollution and their effects

* Describe the sources of pollution and their characteristics

* Describe the effects of air and water pollution on the environment and on human health

* Explain the importance of Environmental Legislation for pollution prevention and control

* Evaluate the preventive measures for the control of air pollutants – SPM

* Select the most appropriate technique to control SOx, NOx, COx, CHx

* Describe the primary, secondary and territory treatment techniques waste water treatment methods

* Propose control measures of pollutants emitted from different industries like paper and pulp

* Plan to select most appropriate technique to control pollutants from petrochemical and refineries

* Explain the control aspects of pollutants from Fertilizer, Pharmaceuticals

* Elucidate the control aspects of pollutants from tannery, sugar and alcohol industries, metal finishing industries

Text books:-

1. S.P.Mahajan., Pollution control in process Industries, Tata McGraw hill publishing company.

2. Arcadio P. Sincero and Georgia Sincero., Environmental Engineering

3. Environmental Pollution Control., by C.S.Rao, wiely eastern ltd.

IPCE-2.1.2 C: Elective-VI (Corrosion Engineering)

Common for M.Tech (Chemical, MPE, CACE, IPCE, Biotechnology)

Course Objectives:

* Basic aspects of electrochemistry relevant to corrosion phenomena,

* Importance and forms of corrosion.

* Knowledge on corrosion rate expressions and measurement techniques.

* Basic knowledge on remedial measures for corrosion.

Course Outcomes:

At the end of the course, the student will be able to

* Identify various forms of corrosion.

* Determine corrosion rates for metals from their polarization curves

* Analyze corrosion rate characteristics from electrochemical impedance spectroscopy

* Select suitable corrosion resistant coatings, oxide layers for various applications

SYLLABUS

Introduction and scope: Corrosion definition, wet and dry corrosion, mechanism, electro-chemical principles and aspects of corrosion, Faradays laws, resistance, specific resistance, conductance, specific conductance, transport numbers, ionic mobility, corrosion rate expressions, calculation of corrosion rates, thermodynamic aspects of corrosion, equilibrium potential, Nernst equation for electrode potential, EMF series, over voltage, application of Nernst equation to corrosion reactions,

Polarisation and corrosion potentials: References electrodes for corrosion measurements, types of polarisation, concentration, activation and resistance polarizations, Tafel constant, Evans diagrams, anodic control, cathodic control, mixed control, Pourbaix-diagram for Fe-H_2O system,

Various forms of corrosion: Uniform attack, galvanic corrosion, crevice corrosion, pitting corrosion, intergranular corrosion, selective leaching (dezincification), cavitation damage, fretting corrosion, erosion corrosion, and stress corrosion and remedial measures,

Prevention techniques: Modification of the material by alloying, appropriate heat treatment, chemical and mechanical methods of surface treatment, metallic, non-metallic linings, inhibitors, passivity, Cathodic protection and anodic protection.

TEXT BOOKS:

1. 'Corrosion Engineering' by Mars G. Fontana, Tata McGraw Hill Publishing Company, New Delhi

2. 'Corosion and Corrosion Control' by H.H.Uhllg, John Wiley & Sons Inc., America

REFERENCE BOOKS:

1. 'Electrochemistry' by Samuel Glasstone, Litton Educational Publishing Company

2. 'Electrochemistry, Principles & Applications' by Edmond C.Potter, Cleaver Hume Press Limited.

SCHEME OF INSTRUCTION & EXAMINATION

1/2 M.TECH (BIOTECHNOLOGY) FIRST SEMESTER

(With Effect From 2020-21 Admitted Batch Onwards)

Under Choice Based Credit System

Code No.	Course	Credits	Theory	Tutorial	Lab	Total	Sessional marks	Exam marks	Total marks
BIO 1.1.1	Advanced Microbiology	3	3	1	—	4	30	70	100
BIO 1.1.2	Advanced Biochemistry	3	3	1	—	4	30	70	100
BIO 1.1.3	Elective-I	3	4	—	—	4	30	70	100
BIO1.1.4	Elective-II	3	4	—	—	4	30	70	100
BIO1.1.5	Research Methodology & IPR	2	4	—	—	4	30	70	100
BIO1.1.6	Audit Course–1*	0	2	-	—	2	—	—	—
BIO 1.1.7	Elective lab	2	—	—	3	3	50	50**	100
BIO 1.1.8	Seminar	2	—	—	3	3	100	—	100
	TOTAL	18	20	2	6	28	300	400	700

*To be included as 'Qualified' or 'Not Qualified' in the marks list

**Only internal evaluation.

Elective-I: 1. Bioanalytical Technics
2 Bioinformatics
3. Biosafety & Bioethics

Elective-II: 1. Corrosion Engineering-I
2. Energy Engineering-I
3. Reaction Engineering-I

Audit Course 1: 1. Yoga for working professionals
2. Organizational Behaviour

SCHEME OF INSTRUCTION & EXAMINATION

1/2 M.TECH (BIOTECHNOLOGY) SECOND SEMESTER

(With Effect From 2020-21 Admitted Batch Onwards)

Under Choice Based Credit System

Code No.	Course	Credits	Theory	Tutorial	Lab	Total	Sessional marks	Exam marks	Total marks
BIO 1.2.1	Genetic Engineering	3	3	1	—	4	30	70	100
BIO1.2.2	Advanced Biochemical Engineering	3	3	1	—	4	30	70	100
BIO 1.2.3	Advanced Downstream Processing	3	3	1	—	4	30	70	100
BIO 1.2.4	Elective-III	3	4	—	—	4	30	70	100
BIO1.2.5	Elective-IV	3	4	—	—	4	30	70	100
BIO1.2.6	Audit Course-2*	0	2	-	—	2	—	—	—
BIO 1.2.7	Elective lab	2	—	—	3	3	50	50	100
BIO 1.2.8	Seminar	2	—	—	3	3	100	—	100
	TOTAL	19	19	3	6	28	300	400	700

*To be included as 'Qualified' or 'Not Qualified' in the marks list

Elective-III: 1. Industrial Biotech products
2. Pharmaceutical Biotechnology
3. Agricultural Biotechnology

Elective-IV: 1. Corrosion Engineering-II
2. Energy Engineering-II
3. Reaction Engineering-II

Audit Course 2 : 1. Disaster Management
2. Entrepreneurship

SCHEME OF INSTRUCTION & EXAMINATION

2/2 M.TECH (BIOTECHNOLOGY) FIRST SEMESTER

(With Effect From 2020-21 Admitted Batch Onwards)

Under Choice Based Credit System

Code No.	Course	Credits	Theory	Tutorial	Lab	Total	Sessional marks	Exam marks	Total marks
BIO 2.1.1	Elective-V	3	4	—	—	4	30	70	100
BIO2.1.2	Elective-VI(Open Elective)	3	4	—	—	4	30	70	100
BIO 2.1.3	Dissertation (preliminary)	9	—	—	—	—	100	—	100
	TOTAL	15	8	—	—	8	160	140	300

Note: The dissertation shall be evaluated through Viva-voce examination by a committee with HOD, Chairman, Board of Studies and Research guide as members. The marks shall be awarded in the ratio of 30,30 and 40 percent by the members Respectively

Elective-V: 1. Enzyme Engineering
2. Stem cells in health care
3. Environmental Biotechnology

Elective-VI: 1. Nano Technology
2. Pollution Control
3. Corrosion Engineering

SCHEME OF INSTRUCTION & EXAMINATION

2/2 M.TECH (BIOTECHNOLOGY SECOND SEMESTER

(With Effect From 2020-21 Admitted Batch Onwards)

Under Choice Based Credit System

Code No.	Course	Credits	Theory	Tutorial	Lab	Total	Sessional marks	Exam marks	Total marks
BIO 2.2.1	Dissertation	16	—	—	—	—	—	100	100
	TOTAL	16	—	—	—	—	—	100	100

Note: The dissertation shall be evaluated through Viva-voce examination by a committee with an external member nominated by University, HOD, Chairman, Board of Studies and Research guide as members. The marks shall be awarded in the ratio of 20, 20, 20 and 40 percent by the members respectively

I SEMESTER

BIO-1.1.1: ADVANCED MICROBIOLOGY

Objectives:

To understand basic as well as advanced aspects of microbiology like Epidemiology and infectious diseases and immunology.

Outcome :

Students are enriched with both theoretical and practical approaches to understand the problem and possible solutions.

Syllabus

UNIT-1 : Introduction to Microbiology: Origin and evolution of microorganisms, history of Microbiology, nature and scope of microbiology, major characteristics of prokaryotes and Eukaryotes, structure and functioning of bacterial cell, staining reactions. Classification of microorganisms: Major characteristics of microorganisms, concepts of Classification, classification methods, principles of nomenclature and identification, Modem trends in classification. General features and classification of some groups of microorganisms - Algae, Fungi, Chlamydiae, Rickettsiae, Mycoplasmas, Viruses and Protozoa, economic importance of Micro-organisms

Learning outcomes:

By the end of the topic, the student will be able to –understand and identify various micro organisms. —memorize scientific names of individual micro organisms.

UNIT-2 : Methods in microbiology: Nutritional requirements, nutritional types of bacteria, Characteristics of culture medium, type of culture media and preparation of culture media, isolation of microorganisms - general and selective methods, isolation of bacteria in pure culture, enrichment - enrichment methods, staining techniques, culture characteristics, maintenance and preservation of cultures, culture collections.

Learning outcomes:

By the end of this unit student will be able to -prepare the culture media and isolations procedure, and staining procedures. -Adapt, practice & perform various microbiological techniques.

UNIT-3 : Reproduction and growth: Reproduction in bacteria, genetic transfer in bacteria, Bacterial growth, bacterial growth curve, growth measurement techniques, factors affecting growth, control of microorganisms by physical and chemical methods.

Metabolism and energy production: Respiratory chain, energy production by aerobic and anaerobic process, energy production by photosynthesis. Microbiology of air, water, soil, milk and food.

Learning outcomes:

By the end of the topic the student will be able to learn - the process of aerobic and anaerobic energy production - understand & describe various metabolic activities which occur in microbes.

UNIT-4 : Epidemiology and infectious diseases: Epidemiological markers, role of host in infectious diseases - Air borne, water borne and food borne diseases.

Learning outcomes:

By the end of the unit the student can learn - different epidemiological markers. - study & identify various infectious diseases caused by micro organisms.

UNIT-5 : Immunology: Natural resistance, internal defense mechanisms, non-specific defense mechanisms, immunity, types of immunity, immune systems, antibody and its diversity, Hypersensitivity, transplantation, autoimmunity, AIDS and other immune deficiencies, vaccines, types of vaccines, production of vaccines and synthetic vaccines, monoclonal anti bodies and their use, antibiotics, history of antibiotics, classification and production of antibiotics, microbial toxins, types of microbial toxins, effects of microbial toxins and their control.

Learning outcomes:

By the end of the unit the student can learn -different types of vaccines, defense mechanism of immune system, history and role of antibiotics. - Understand & analyze the types of immunity & immune systems.

TEXT BOOKS:

1. Microbiology by M. J. Pelczer, E. C. S. Chan, N. R. Kries. Tata McGrew Hill publications

2. Microbiology fundamentals and applications by S. S. Purohit. Agro botanical. Publications.

REFERNCE BOOKS:

1. Microbiology by Prescott, Harley, Klein. Mc Graw-Hill publications

2. General Microbiology by Roger Y. Stainer, Edward A. Adebery, John L. Ingraham. Published by Macmillan Press LTD.

BIO -1.1.2: ADVANCED BIOCHEMISTRY

Objectives:

* To study about the biomolecules and importance of biochemistry in the advanced level.

* To study the detailed structure and function of biomolecules like carbohydrates, amino acids, proteins, lipids and nucleic acids.

* To study the detailed structure and function of biocatalysts, enzymes. To study various types of enzyme inhibitions.

* To study in detailed vitamins, membrane assembling, bioenergetic principles and ATP cycle.

* To study the metabolism in advanced level and biosynthesis of fatty acids, DNA, RNA, and proteins.

* The student obtains advanced level knowledge n biomolecules and metabolic process a base for the higher research activity.

Outcome:

* Students will obtain knowledge in the advanced structure of biomolecules.

* Student will obtain knowledge in the biosynthesis and degradation of biomolecules.

* Student will obtain advanced knowledge in the metabolism and bioenergetic principles.

* The students can carry out independent research work to improve and to invent new biomolecules and can understand new metabolic processes.

SYLLABUS

Scope and importance of biochemistry, molecular logic of living matter,origin of biomolecules. Molecular structure of Water, macromolecular structure of water, hydrogen bonds, dissociation of water.

Unit-1 : Carbohydrates: classification of carbohydrates, structure and properties of monosaccharides (ribose, glucose, fructose), disaccharides (maltose, lactose, sucrose) and polysaccharides (Starch, glycogen and cellulose).

Mechanism of photosynthesis, Embden-Meyerhof pathway of glucose metabolism(glycolysis), citric acid cycle(Krebs cycle), electron transport and oxidative phosphorylation.

Learning Outcomes:

on completion of the unit, the learner will be able to - Understand & describe various types of carbohydrates. -Describe the pathways & their metabolism.

Unit-2 : Amino acids and proteins: Classification and properties of amino acids and proteins, peptide bond, structural organization of proteins: primary, secondary, tertiary and quaternary structure of proteins. Biochemical function of proteins, denaturation of proteins. Biosynthesis of proteins (translation).

Learning Outcomes:

on completion of the unit, the student will be able to learn and - Understand & identify various types & structures of amino acids - Development & synthesis of amino acids.

Unit-3 : Lipids: classification, structure and physiological functions of triglycerides, fattyacids, phospholipids, cerebrosides, gangliosides and cholesterol. Biosynthesis of fattyacids- palmitic acid biosynthesis, â-oxidation of fatty acids.

Learning Outcomes:

By the completion of the unit, the student will be able to learn and - Identify, classify various lipids in detail. -Identify & synthesize some fatty acids.

Unit-4 : Nucleic Acids: Structure and properties of purines and pyrimidine bases, nucleosides, nucleotides.Structure of nucleic acids-DNA and RNA. Biosynthesis of DNA (replication).

Biosynthesis of RNA (transcription).

Learning Outcomes:

on completion of the unit, the student will be able to learn and - Understand & interpret the structures of all the nucleic acids. - Biosynthesize various nucleic acids.

Unit-5 : Enzymes: Classification of Enzymes, Mechanism of Enzyme action, factors affecting enzyme action, co-enzymes and regulatory enzymes.

Enzyme inhibition-competitive, non-competitive and uncompetitive inhibitions. Structure and functions of vitamins. Membrane assembly and transport across the membranes. Bioenergetic principles and ATP cycle.

Learning Outcomes:

By the completion of the unit, the student will be able to learn and - Compare & classify various enzymes - Understand the mechanism of enzyme action.

Text Books:

1. Textbook of Biochemistry by Albert-Lehninger, Kalyani Publishers,Ludhiana,New Delhi.

2. Principles of Biochemistry- Lehninger, Nelson and Cox-CBS Publishers and distributors,Delhi.

3. A text book of Biochemistry by A.V.S.S.Rama Rao,UBS Publishers and Distributors Ltd,New Delhi,Chennai.

4. Fundamentals of Biochemistry-J.L.Jain,S.Chand and company Ltd. New Delhi.

BIO -1.1.3: Elective –I

BIO -1.1.3 A: Elective –I (Bio-Analytical Techniques)

Objectives :

The course is designed to impart the knowledge in the field of Pharmaceutical Analysis. The various modern analytical techniques like UV-Visible, IR, NMR, Mass, GC, HPLC, different chromatographic methods and other important topics will be taught to enable the students to understand and apply the principles involved in the determination of different bulk drugs and their formulation. In addition to theoretical aspects, the basic practical knowledge relevant to the analysis will also be imparted.

Outcome:

The appreciable knowledge will be gained in the Modern Analytical Techniques and can apply the theories in the analysis of various bulk drugs and their formulations. Able in developing the new methods for the determination and validate the procedures.

SYLLABUS

Unit I : Chromatographic Techniques - Affinity - Adsorption - paper - Thin layer - Column - Ion Exchange - Gel Chromatography - Applications.

Learning Outcome:

* The students will be able acquire knowledge in handling instruments for the analysis of the samples.

* Understand the principles of Chromatographic Techniques.

Unit II : Gas liquid chromatography - High Pressure liquid chromatography - Equipment - Applications.

Learning Outcome:

* Understand advantages, disadvantages and applications of chromatographic techniques.

Unit III : Spectrophotometric Techniques - IR - UV - Visible - NMR - ESR - Optical density - Circular dischroism.

Learning Outcome:

* The students will be able to demonstrate instruments required for spectral methods.

* Understand the principles and applications of UV - Visible - NMR – ESR etc.

Unit IV : pH - pH titrations - Determination of pKa values - Buffers - Preparation - Buffer Action - Physiological buffers - potentiometric titration - centrifugal dialysis - lyophilization

Learning Outcome:

* Determine different values in pH titrations.

* Explain preparation and role of various buffers in pH titrations.

* Discuss stepwise procedure in potentiometric titration.

Unit V : Notes from Unit-I to Unit-IV

Learning Outcome:

* Prepare material for teaching and learning process.

* Able to understand and demonstrate various instrumental methods.

Text Books:

1. " Instrumental methods of Chemical Analysis - Chatwal, G & Anand, S. Himalaya Publishing House, Bombay.

2. "Instrumental methods of Chemical Analysis - Sharma, B.K. Goel Publishing House, Meerut.

3. "Instrumental Methods Analusis - Willard, Merritt, Dean & Settle, CBS Publishers & Distributors, Delhi.

BIO -1.1.3 B: Elective –I (Bioinformatics)

SYLLABUS

Unit-1 : Introduction, Molecular Biology and Bioinformatics, Biological database: Primary, Secondary and Structural data bases, tools for web search, data retrieval tools

Learning Outcomes:

By the completion of the unit, the student will be able to learn - The basics knowledge of bioinformatics and the about the biological databases. - data retrieval tools and structural databases.

Unit-2 : Genome analysis and gene mapping: sequence assembly problem, genetic mapping and linkage analysis, genome sequencing, sequence assembly tools, Human genome project.

Learning Outcomes:

By the completion of the unit, the student will be able to learn - Genetic mappimng ang linkage analysis - genome sequencing, and tools and human genome project.

Unit-3 : Alignment of pairs of sequences, scoring matrices, multiple sequences, phylogenetic analysis, Tree evaluation, automated tools for phylogenetic analysis, working with FASTA and BLAST.

Proteomics: Tools and techniques in proteomics, protein – protein interactions, gene family identification methods. Computational Methods for pathways and systems Biology: Analysis of pathways, metabolic network properties, metabolic control analysis, simulation of cellar activities.

Learning Outcomes:

By the completion of the unit, the student will be able to learn - Alignment of pairs of sequences, phylogenetic analysis with blast and fasta. - Tools and technioques in proteomics, analysis of biological cellular pathways.

Unit-4 : Gene identification and prediction: Basis for gene prediction, pattern recognition, gene prediction methods, working with DNA, Micro arrays, Micro array analysis.

Learning Outcomes:

By the completion of the unit, the student will be able to learn - gene identification and prediction methods.

Unit-5 : Protein classification and structure visualization: structure – based protein classification, protein structure databases, visualization databases and tools, protein structure alignment, tools for plotting protein-ligand interaction. Protein structure prediction: Analysis and prediction of primary structure and secondary structure, motifs, profiles, patterns and fingerprints search, Ab Initio approach, 2-D structure prediction, protein function prediction from DNA sequence.

Learning Outcomes:

By the completion of the unit, the student will be able to learn - Protein structure and classification, visualization of databases, protein – ligand interaction. - Structure prediction from DNA sequence.

Text-book:

S.C..Rastogi, N.Mendiratta and P.Rastogic, Bioinformatics, Prentice- Hall of India Pvt.Ltd, New Delhi, 2004

Reference books:

1. T.K.Attwood and D.J. Parry-Smith, Introduction to Bioinformatics, Pearson Education Asia, Delhi, 2002

2. A.M. Lesk, Introduction to Bioinformatics, Oxford University press, New Delhi, 2004.

BIO -1.1.3 C: Elective –I (Systems Biology)

Course Outcomes:

The student will be able to

* Explain the principles of system biology and experimental techniques.

* Apply achieved methodological knowledge to biologically relevant problems.

* Interpret the results from commonly used systems biology methods.

SYLLABUS

Introduction: Basic principles of systems biology, experimental techniques, Standard models and approaches: Metabolism- enzyme kinetics and thermodynamics, metabolic networks, metabolic control analysis,

Biological processes: Signal transduction- introduction, function and structures, interactions, structural components, signaling selected biological processes, Evolution: Introduction, mathematical models, prediction of biological systems, data integration,

Applications: Systems biology in various fields, databases and tools, modeling tools.

TEXT BOOKS:

1. “Systems Biology in Practice-Concepts, Implementation and Application” by Edda Klipp and Ralf Herwig, Wiley VCH, I Edition

2. “Systems Biology: Definitions and Perspectives” by Lilia Alberghina and Hans V. Westerhoff, Springer, 2005.

REFERENCE BOOKS:

1. “Systems Biology: Principles, Methods, and Concepts” by Andrzej K. Konopka, CRC Press, 2006

2. “Stochastic Modelling for Systems Biology” by Darren James Wilkinson, CRC Press, 2006.

BIO -1.1.4: Elective –II

BIO-1.1.4 A - Elective-II (Corrosion Engineering-I)

Common for M.Tech (Chemical, MPE, IPCE, CACE & Biotechnology)

Objectives : The main objectives are to provide:

1. Basic aspects of electrochemistry relevant to corrosion phenomena,

2. Importance and forms of corrosion.

3. Knowledge on corrosion rate expressions and measurement techniques.

4. Knowledge on factors influencing corrosion of iron and steel exposed to atmospheric, soil and aqueous medium.

5. Basic knowledge on remedial measures for corrosion.

Outcome: At the end of the course, the student will be able to

1. Acquires knowledge on basic principles of electrochemistry, importance of corrosion.

2. Predict whether corrosion will occur for a particular environment.

3. Estimate corrosion rates and analyze.

4. Identify the type of corrosion and propose viable remedial measures.

SYLLABUS

Basic Concepts and Outlines of Electrochemistry: Fundamentals of Electrochemical reactions, Faraday's Laws Electrolytic and ionic conductance, ionic mobility's, Transport Nos. Galvanic Cell and Electrolytic cells.

Definition and importance of corrosion, Dry cell, analogy, Corrosion Cells, Types of Corrosion Cells- a) Dissimilar electrode cells b) Concentration cells such as a salt concentration cells, differential aeration cells c) differential Temperature cells. Corrosion Rate Expresions - mdd, ipy, cpy, mpy, etc.

LO1: Choose a specific cell for a given situation

LO2: Identify the type of corrosion cell that will form in that particular environment

Corrosion Tendency and Electrode Potentials: Free Energy changes, Development of Nernst Equation for calculation of Half-cell potentials, Hydrogen electrode, Spontaneity of a reaction, Reversible cells and potentials – convention of Sign and calculations of EMF from standard Equilibrium potentials., EMF Series and Galvanic series, Reference Half Cells – Calomel, Silver-Silver Chloride and Saturated Copper-Copper Sulphate Half Cells. Pourbaix Diagram for Iron, Aluminum and magnesium, limitations of pourbaix diagrams.

LO3: Predict the tendency of corrosion to occur

LO4: Identify the corrosion zones based on pH of media

Polarization and Corrosion Rates: Polarization and a Polarized Cell, Causes of Polarization – Concentration Polarization, Activation Polarization and IR drop. Hydrogen Over potentials, combined polarization and Mixed potential theory. Tafel Slopes and Tafel Equation. Graphical method of expressing Corrosion Reactions (Polarization diagrams/Evans diagrams), Derivation of Stern-Geary Equation, Influence of Polarization on Corrosion rates.

LO5: Derive the equations for estimating corrosion rates

LO6: Evaluate and Analyze data for corrosion rates

Passivity: Characteristics of Passivation, Flade potential, behavior of passivators, transpasivity, Theories on Passivity.

Forms of Corrosion: Uniform attack, Galvanic Corrosion, Crevice Corrosion, Pitting, Intergranular Corrosion, Selective Leaching, Erosion Corrosion and Stress Corrosion. Hydrogen damage. Factors influencing, mechanisms and prevention techniques for all forms of corrosion. Calculation of Corrosion rates using weight lost method and Polarization data. Electrochemical Impedance Spectroscopy.

Effect of Dissolved Oxygen (Air saturated Water, High Partial Pressure of Oxygen and Anaerobic bacteria), Temperature, pH, Galvanic coupling, velocity, dissolved salts concentration. Wet and dry corrosion.

LO7: Identify the type of corrosion

LO8: Recommend proper remedial measures

Textbooks :

1. Corrosion and Corrosion Control by Herbert, H. Uhlig John Wiley and Sons Inc., New York.

2. Corrosion Engineering by Mars F Fontana, McGraw Hill.

3. An Introduction to Electrochemistry by Samuel Glass stone, Affiliated East West Press Pvt. Ltd.,

Reference Books :

1. Corrrosion Volumes 1 & 2 by L.L. Shrier, Newnes - Butter-worths, London.

BIO - 1.1.4 B - Elective-II (Energy Engineering-I)

Common for M.Tech (Chemical, MPE, IPCE, CACE & Biotechnology)

Objectives:

To lean overview of solar radiation and it's potential for collection to meet the energy needs of mankind and potential for solar energy option. To learn measuring techniques of solar radiation and its compilation.

To learn various design and operational aspects of solar energy collection and storage.

To learn the design and operation of solar energy appliances like liquid flat plate collectors, Solar Air Heaters, Thermal energy storage, Thermal energy storage, Solar Pond, Solar thermal power generation.

To learn theory and application of Photovoltaic cells

Outcome:

The student learns collection and design of various kinds of equipment operated on solar energy. The student learns principles and practice of Photo voltaic cells.

SYLLABUS

The Solar Energy option

Thermal conversion – collection and storage Thermal applications – photovoltaic conversion – wind energy – Energy from Bio – mass – ocean thermal energy conversion.

Solar Radiation

Solar Radiation outside the earths – atmosphere Solar radiation at the Earth's surface – Instruments for measuring Solar Radiation – Solar Radiation data – Solar Radiation Geometry Empirical equations for predicting the availability of Solar Radiation – Solar radiation on tilted surface.

Liquid flat – Plate Collectors

Components of liquid flat plate – various types of collectors – Performance Analysis – Transmissivity – Absorptivity product – Overall loss coefficients and heat Transfer correlations – Collector efficiency heat removal factors – effect of various parameters on performance. Transient Analysis – Testing procedures.

Solar Air Heaters

Various types of solar Heaters – Performance Analysis of a conventional Air Heater – Testing procedures – Concentrating collectors – various types of concentrating collectors cylindrical and parabolic collectors – General receiver collectors.

Thermal energy storage

Sensible heat storage – Latent heat storage – Thermochemical storage

Solar Pond

Description – Performance analysis – Experimental studies – Operational problems.

Solar Air Conditioning and Refrigeration

Heat pump cycle – Coefficient of performance of the heat pumps – solar air-conditioning with absorption – Refrigeration system (Ammonia water and lithium bromide – water systems).

Solar thermal power generation

Thermal and direct electricity generation – Major sub-stations of a solar thermal power plant, Examples of installed systems – Concentration ratio. Temperature and efficiency concepts – Solar farm and tower – Economics.

Photovoltaic Energy Conversion

Photovoltaic Energy Conversion Fundamentals – band theory of solids – Physical processes in a solar cell – Solar cell with light incidence – Solar cell module – Silicon Solar Cells – Copper Sulphate / Cadmium sulphide Solar Cells.(Banasal et at.,chapters 9;Taylor, chapters 6, pages 256-298.

Text Books:

1. Solar Energy: Principles of thermal collection and storage by S.P. Sukhatme, Tata McGraw Hill, New Delhi 1984 (Chapters 2 to 8)

2. Renewable energy sources and conversion technology by N. K. Bansal, M. Kleemann, Michael Mcliss, 1990 (Chapters 2 – 9).

BIO - 1.1.4 C - Elective-II (Reaction Engineering-I)

Common for M.Tech (Chemical, MPE, IPCE, CACE & Biotechnology)

Unit I : (Scope : J.M. Smith : Chapter 7): Heterogeneous Processes, catalysis, and absorption: Global Rates of Reaction - Types of Heterogeneous Reactions - The nature of catalytic Reactions - The Mechanism of catalytic Reactions - Surface Chemistry and Absorption - Absorption Isotherms - Rates of Absorption.

Unit II (Scope : J. M. Smith: Chapter 8 : Solid Catalysts: Determination of surface area - Void Volume and solid density - Fore volume distribution - Theories of Heterogeneous Catalysis - Classification of catalysts - Catalyst Preparation - Promoters and Inhibitors Catalyst Deactivation (Poisoning).

Unit III: (Scope: J.M. Smith : Chapter 9): Rate equations for fluid - Solid Catalytic Reactions: Rates of adsorption, Desorption, Surface Reaction - Rate equations in terms of Fluid phase concentrations at the catalyst surface - Qualitative analysis of rate equation - Quantitative inter pretation of Kinetic data - Redox Rate equations.

Unit IV: (Scope : Octave Levenspiel : Chapter 15) : Deactivating Catalysts : Mechanism of Catalyst Deactivation - The ratre of equation - The rate of equation from experiment - Batch - solids: Determining the rate for Independent Deactivation Batch - solids : Determining the rate of parellel, series or side - by - side Deactivation - Flowing solids experimental Reactors - Finding the Mechanism of Decay from experiment Design.

Unit V: (Scope : J. M. Smith : Chapter 10) : External transport Processes in Heterogeneous Reactions: Fixed bed reactors - The effect of physical processes on observed rate of reaction - Mass and Heat transfer coefficients (fluid particle) in packed beds - Quantitative treatment of external transport effects - Stable operating conditions - Effect of external transport Processes on selectivity. Fluidised bed reactors - Particle - fluid Mass and Heat transfer Slurry Reactors - Mass transfer coefficients: Gas bubble to liquid (K_1) - Mass transfer coefficients: Liquid to particle (K_c) - The effect of mass - transfer on observed rates Trickle - Bed reactors - mass transfer coefficients: Gas to liquid ($K_1 a_g$) - Liquid to particle ($k_c a_c$) - Calculation of global rate.

Text Books:

1. Smith. J.M., " Chemical Engineering Kinetics", McGraw Hill book Company, New Delhi (Third Edition) 1981.

2. Octave Levenspiel, " Chemical Reaction Engineering" , Wiley Eastern Limited - Second Edition - 1972.

Reference Books :

1. Thomas, J.M. And Thomas, W.J. " Introduction to the Principles of Heterogeneous Catalysis". Academic Press Inc., New York 1967.

2. Carbnerry, James, J., " Chemical and Catalytjic Reaction - Engineering", McGraw - Hill, Engineering Series.

BIO 1.1.5: RESEARCH METHODOLOGY AND IPR

Common for M.Tech (Chemical, MPE, IPCE, CACE & Biotechnology)

Unit 1: Meaning of research problem, Sources of research problem, Criteria Characteristics of a good research problem, Errors in selecting a research problem, Scope and objectives of research problem. Approaches of investigation of solutions for research problem, data collection, analysis, interpretation, Necessary instrumentations

Unit 2: Effective literature studies approaches, analysis, Plagiarism, Research ethics,

Unit 3: Effective technical writing, how to write report, Paper, Developing a Research Proposal, Format of research proposal, a presentation and assessment by a review committee

Unit 4: Nature of Intellectual Property: Patents, Designs, Trade and Copyright. Process of Patenting and Development: technological research, innovation, patenting, development. International Scenario: International cooperation on Intellectual Property. Procedure for grants of patents, Patenting under PCT.

Unit 5: Patent Rights: Scope of Patent Rights. Licensing and transfer of technology. Patent information and databases. Geographical Indications.

Unit 6: New Developments in IPR: Administration of Patent System. New developments in IPR; IPR of Biological Systems, Computer Software etc. Traditional knowledge Case Studies, IPR and IITs.

References:

1. Stuart Melville and Wayne Goddard, "Research methodology: an introduction for science

2. & engineering students'"

3. Wayne Goddard and Stuart Melville, "Research Methodology: An Introduction"

4. Ranjit Kumar, 2nd Edition , "Research Methodology: A Step by Step Guide for beginners"

5. Halbert, "Resisting Intellectual Property", Taylor & Francis Ltd ,2007.

6. Mayall , "Industrial Design", McGraw Hill, 1992.

7. Niebel , "Product Design", McGraw Hill, 1974.

8. Asimov , "Introduction to Design", Prentice Hall, 1962.

9. Robert P. Merges, Peter S. Menell, Mark A. Lemley, " Intellectual Property in New

10. Technological Age", 2016.

11. T. Ramappa, "Intellectual Property Rights Under WTO", S. Chand, 2008

BIO 1.1.6 A: Audit Course-1 (YOGA FOR WORKING PROFESSIONALS)

Common for M.Tech (Chemical, MPE, IPCE, CACE & Biotechnology)

Course objectives:

1. To make the student understand various practices of yoga and yoga diet.
2. To make the student be familiar with various asanas and other associated practices.
3. To make the student appraise the holistic benefits of yoga
4. To make the student identify a therapeutic solution for common health issues.
5. To make the student experience the pranahuti aided meditation.

Course outcomes:

1. The students will discover the importance of yoga for leading a disciplined way of life.
2. The students would improve their wellness by adapting various yogic practices in their day to day life.
3. The students would perceive the holistic benefits of yoga
4. The students can judge the causes of common diseases and can recommend therapeutic solutions based on yogic practices
5. The student can compare the placebo meditation and meditation with pranhuti.

Unit-I: Introduction to Yoga : The Origins of Yoga – Definitions - Concepts - Aims and objectives of Yoga - Yoga is a Science and Art - Ideal Practice of Yoga in the new millennium. Streams of Yoga - Karma Yoga - Bhakti Yoga - Jnana Yoga - Raja Yoga (Astanga Yoga) - Hatha Yoga - Yoga and Diet - - Yoga Disciplined way of life. Difference between Yogasanas and Physical Exercises.

Learning outcomes:

1. After completing this unit, the students will be able to recognize the differences between yogic practices and physical exercises.

2. At the end of this unit, the students will be able assess the relevance of yogic practices for holistic wellness in the contemporary times.

Unit-II: Yogasanas with practical : Loosening the joints- Joint freeing series, Suryanamaskar, Tadasana, Trikonasana, Artha chandrasana, Danurasana, Utkatasana, Dandasana, Pavanamuktasana, Hamsasana, Arthakati chakrasana, Artha chakrasana, Janusirasasana, Vajrasana, Makarasana, Padmasana, Sukhasana, Natrajasana, Savasana. Introduction to Kriyas, Pranayamas, Bandhas and Mudras.

Learning outcomes:

1. The students will be able to demonstrate some selective yogasanas.

2. The students will be able to appraise the importance of allied yogic practices such as pranayama, mudras, bandhas and kriyas.

Unit-III: Physiological benefits of Yoga : Physiological Benefits of Asanas and Pranayama – Chest Cage – Regulation of Breathing – Types of Breathing. Physiological Benefits of Bandhas – Mudras – Kriyas - Meditation – Nadis – Chakras – Kundalini shakti – Psycho-neuro Immunology. Role of Yoga on Psychological Qualities and Psychological Disorders.

Learning outcomes:

1. By studying this unit, the students will be able to value the physiological benefits of yoga practices.

2. The students will be able to support the role of yoga in the treatment of psychological disorders at the end of this chapter.

Unit-IV: Introduction to Yoga Therapy : Essence and Principles of Yoga therapy- Physiology and Pathology in the yoga – Shatra- koshas – doshas- Granthis – Pancha prana – Application of Yoga and its types- Methodology in Yoga Therapy – Factors (Heyam, Hetu, Hanam and Upayam) - Methods (Darsanam, Sparsanam, Prasnam, Nadi, Pariksa) Examination of Vertebra, joints, Muscles, Abdomen and Nervous system and therapeutic applications – Modification of yogic practices for Human Systems- Yogic diet.

Learning outcomes:

1. At the end of the unit, the students become familiar in assessing the health of an individual.

2. After completing this unit, the students can recommend appropriate yoga therapy for health problems faced by an individual.

Unit-V: Meditation : (The student has to maintain a diary to record his observations during meditation. This diary will help him to understand the extent of his progress) Meaning and Concept of Meditation – Need of meditation- techniques of meditation-Tools of meditation-Advantages of Meditation- Experience of meditation- Obstacles. Sahaj Marg Meditation, Heartfulness movement. Elements of sahaj marg meditation: Prayer, cleaning, sitting, satsang, universal prayer and suggestions. Ten maxims of sahaj marg.

Learning outcomes:

1. The student will be well versed in the benefits of meditation at the end of the unit.

2. The student can experience the difference in normal situation and meditative condition after experiencing pranahuti aided meditation.

Reference books

1. George Feuerstein: The Yoga Tradition (Its history, literature, philosophy and practice).

2. Georg Feuerstein. The Psychology of Yoga: Integrating Eastern and Western Approaches for Understanding the Mind.

3. Swamy Satyananda Saraswathi: Asana, Pranayama, Mudra, Bandha (India: Yoga Publications Trust, Munger, Bihar).

4. Swami Sivananda : Practice of Yoga (The Divine Life Society, Shivananda Nagar.P.O.,U.P. Himalayas, India).

5. Krishna Raman: A Matter of Health (Integration of Yoga and western medicine for prevention and cure) (Chennai East West Books(Madras) Pvt. Ltd.,1998.

6. Bhavanani, A.B. (2011): Application of Yoga Concept in the Health Improvement. In: P.Nikic, ed.

7. Ram Chandra, Complete works or Ram Chandra (Babuji) Vol. I, Sri Ram Chandra Misssion, SPHT, Calcutta.

BIO 1.1.6 B- Audit Course -I Organizational Behavior

Common for M.Tech (Chemical, MPE, IPCE, CACE & Biotechnology)

UNIT-I: Organizational Behavior: Concept of Organization - Concept of Organizational Behavior - Nature of Organizational Behavior - Role of Organizational behavior - Disciplines contributing to Organizational Behavior.

UNIT-II: Motivation: Definition - Nature of Motivation - Role of Motivation - Theories of Motivation: Maslow's Need Hierarchy Theory, Herzberg's Motivation Hygiene Theory and McGregor's Theory X and Theory Y.

UNIT –III: Group Dynamics: Meaning - Concept of Group - Types of groups -Formal and Informal groups - Group development - Group cohesiveness and factors affecting group cohesiveness.

UNIT-IV: Leadership: Concept of Leadership - Difference between

Leadership and Management - Importance of Leadership - Leadership styles: Autocratic leadership, Participative leadership and Free Rein leadership.

UNIT-V: Communication: Meaning - Communication Process - Forms of communication: Oral, Written and Non- Verbal communication - Direction of communication: Downward, Upward and Horizontal communication.

UNIT-VI: Organizational conflicts: Concept of conflict - Reasons for conflict - Types of Conflict: Intrapersonal conflict, Interpersonal conflict, Intragroup conflict, Intergroup conflict, Inter organizational conflict - Conflict management.

UNIT –VII: Organizational Change: Nature - Factors in Organizational change -Planned change: Process of planned change - Resistance to change: Factors in resistance to change - Overcoming resistance to change.

Text Books.

1.L.M.Prasad: Organizational Behavior, Sultan Chand & Sons, New Delhi -110002

2.K. Aswathappa: Organizational Behavior, Himalaya Publishing House, New Delhi

Reference Books.

1. Stephen Robbins: Organizational Behavior, Pearsons Education, New Delhi.

II SEMESTER

BIO- 1.2.1- GENETIC ENGINEERING

Objective: A gene is a basic constituent unit of any organism. It is a locatable region of a genome which contains the whole hereditary information of the organism. A gene corresponds to a unit of inheritance. It is a segment of the DNA which determines the special features or functions of the organism. Genetic engineering or genetic modification refers to the process of manipulating the characteristics and functions of the original genes of an organism. The objective of this process is to introduce new physiological and physical features or characteristics.

Outcome: At the end of the course the students would have learnt about the importance of developing and practicing of genetic engineering as noble and beneficial for mankind. Understand the basic processes involved in manipulating genetic information used by recombinant and cloning methods, different ways that genetic engineering has used in manufacturing, agriculture, medicine and identify several current issues surrounding genetic engineering. The domain of genetic engineering can extend from plants to cover both the animal and human life.

SYLLABUS

I. (a) Introduction to Gene manipulation. (b) Enzymology of gene cloning, modification methylases, restriction endonucleases .

Learning Outcomes:

By the completion of the chapter, the student will be able to-- Understand gene manipulations. - Explain various enzymes involved in gene cloning

II. (a) Reverse transcriptase and D N A cloning in E. Coli. (b) Plasmids, cosmids and bacteriophages as cloning vectors.

Learning Outcomes:

By the end of the unit, the student will be able to-- Understand & identify DNA cloning. - Identify various cloning vectors

III. (a) Cloning strategies and gene libraries. (b) Recombinant selection and screening.

Learning outcomes:

By the end of the topic, the student will be able to-- Illustrate various cloning strategies & gene libraries. - Summarize selection & screening of recombinant genes.

IV. (a) Expression of cloned genes cloning in bacteria other than E. Coil, in yeasts, in plant cells and in mammalian cells in culture. b) Micro injection of genes into ocytes, eggs and embryo.

Learning outcomes:

By the end of the topic, the student will be able to -Explain the demonstration & expression of cloned genes. - Identify & Explain the process of micro injections of genes.

V. (a) The genetic code and regulation of gene expression. b) Application of genetic Engineering in the fields of biology, medicine and industries.

Learning outcomes:

By the end of the unit, the student will be able to - Understand Genetic code & its regulation. - Select & develop numerous applications of Genetic Engineering.

Text Books:

1. Introductory Bio-Technology by R. P. Singh.

2. Principles of genetic Engineering by old and primarose.

BIO-1.2.2- ADVANCED BIOCHEMICAL ENGINEERING

Objectives:

1. To introduce enzymes, enzymatic and microbial growth kinetics

2. To introduce transport of materials in biological systems with respect to mass transfer and heat transfer

3. To introduce different types of bio-reactors and special reactors like animal and plant cell reactors

4. To introduce immobilization and sterilization techniques

Outcome:

1. To determine the enzyme activity, parameters affecting activity and enzyme immobilization

2. To know gas liquid mass transfer. To determine the $K_L a$ and to know inter particle and intra particle diffusion

3. To know about working and analysis of all types of rectors

4. To know thermal death kinetics and sterilization of air and medium

SYLLABUS

Enzyme Kinetics: effects on enzyme activity, deactivation, immobilized enzymes.

Learning Outcomes

1. Explain lock and key mechanism of enzyme kinetics
2. Describe different methods of immobilization
3. Distinguish the factor affecting enzyme activity.
4. Derive MM equation.

Microbial growth kinetics: Batch growth, unstructured models, growth in continuous culture, structured models, product formation kinetics, cell immobilization.

Learning Outcomes

1. Compare structured and unstructured models
2. Explain different methods of cell immobilization.
3. Examine the batch growth curve and batch cultivation.
4. Interpret the rate of continuous culturing.

Transport Phenomena: Gas-liquid Mass transfer; Theoretical models for K_{La}, interfacial area and bubble oxygen transfer, gas-liquid mass transfer of components other than oxygen. Mass transfer into solid particles: External transfer, intra particle diffusion.Heat transfer correlations.

Learning Outcomes

1. Explain gas liquid mass transport in biological systems.
2. Illustrate different methods of $K_L a$ determination.
3. Compare external transport and intra particle diffusion.
4. Summarize heat transfer correlations.

Bioreactors: Review of various types of bioreactors used in the fermentation industry. Multiphase bioreactors: packed bed, bubble-column, fluidized bed and trickle-bed reactors. Alternate fermenters: new bioreactor configurations used in the fermentation technology and plant cell reactor technology.

Learning Outcomes

1. Demonstrate different types of bioreactors.
2. Describe alternate bioreactor configurations.

Sterilization: Sterilization methods, thermal death kinetics, design criterion, batch and continuous sterilization, air sterilization.

Learning Outcomes

1. Define sterilization and explain thermal death kinetics.
2. Explain air sterilization.
3. Compare batch and continuous sterilization

TEXT BOOK:

Shuler, M. L and F. Kargi, Bioprocess Engineering: Basic concepts, 2nd ed., Prentice Hall India, New Delhi, 2003.

REFERNCES:

1. Lee, J. M., Biochemical Engineering (e Book), Prentice Hall, Englewood Cliffs, 2001.

2. Bailey, J. E., and D. F. Ollis, Biochemical Engineering Fundamentals, 2nd edition, Mcgraw-Hill, New York, 1986.

3. Blanch, H. W., and D. S. Clark, Biochemical Engineering, Marcel Dekker, New York, 1996.

4. Swamy,A.V.N.,' Fundamentals of Biochemical Engineering' , BS publications, 2007

BIO-1.2.3-ADVANCED DOWN STREAM PROCESSING

Objectives:

1.To learn and understand the applied concepts of downstream processing.

2. To enable the students to Understand the methods to obtain pure proteins, enzymes and in general about Product development R & D Have depth knowledge and hands on experience with on Downstream processes

Outcome:

At the end of the course,

1. The student would have learnt about, methods to obtain purify various types of compounds

2. Purification and characterization of various types of bioproducts in large scale level.

3. To execute precise and efficient bioseperations, which in cost effective and yield high degree of pure substance

SYLLABUS

UNIT.I: Introduction - An Overview of Bioseparations: Bioprocesses, Range and characteristics of bioproducts, Need for down stream processing, Characteristics of Fermentation broths, An overview of bioseparations; A few case studies.

Cell Disruption: Intracellular products, Cell wall, Cell disruption, Proteins of inclusion bodies. Reverse Phase and Hydrophobic Interaction Chromatography: hydrophobic interaction chromatography; Reverse phase chromatography. Basic theory of retention in RPC and HIC; Hydrophobic Interaction Chromatography. Electrokinetic Methods of Separation: the various Method; Electrophoresis; Capillary Electrophoresis; Isoelcctric Focusing; Isotachophoresis.

Learning outcomes:

* Recognize the structures of cells that cause cell lysis to be necessary for the recovery of bioproducts.

* Summarize the factors to be considered in selection of cell disruption method.

* Differentiate between mechanical and non-mechanical cell disruption methods and within these categories, choose appropriate methods for general classes of applications.

UNIT.2: Liquid- Liquid Extraction with Ternary Systems-Instructional objectives: industrial example; Equipment: mixer- settlers, spray columns, packed columns, plate columns, columns with mechanically agitated agitation; General design considerations; Hunter- Nash graphical equilibrium- stage method: number of equilibrium stages, minimum and maximum solvent- to-feed flow rate- ratios, use of right- triangle diagrams, use of an auxiliary distribution curve with McCabe- Thiele diagram, extract and raffinate reflux; Maloney- Schubert graphical equilibrium- stage method; Theory and scale-up of extractor performance: mixer- settler units, multi-compartment columns, axial dispersion.

Learning outcomes:

* Describe the extraction separation process

* Understand the equipment for extraction.

* Apply the principles of extraction and develop basic design of extractor.

UNIT.3: Membrane Separations: Instructional objectives: industrial example; Membrane materials; Membrane modules; Transport in membranes: porous membranes, bulk flow, liquid diffusion in pores, gas diffusion, nonporous membranes, solution- diffusion for liquid mixtures, solution-diffusion for gas mixtures, module flow patterns, cascades, external mass -transfer resistances, concentration polarization and fouling; Dialysis and electro dialysis; Reverse osmosis; Gas permeation; Pervaporation; Ultra filtration: process configurations; Micro filtration: constant- flux operation, constant- pressure operation, combined operation. Introduction to liquid membranes, principle, its advantages and its applications.

Learning outcomes:

* understand the principles and materials properties for different membrane separation processes

* Identify the best membrane modules and manufacturing process for different applications

* identify and design the suitable membrane separation technique for intended problem

UNIT.4: Crystallization: Instructional objectives: industrial example; Crystal geometry: crystal- size distributions, differential screen analysis, cumulative screen analysis, surface- mean diameter, mass- mean diameter, arithmetic-mean diameter, volume- mean diameter; Thermodynamic considerations: solubility and material balances, enthalpy balances; Kinetic and transport considerations: super saturation, nucleation, crystal growth; Equipment for solution crystallization: circulating, batch crystallizers, continuous, cooling crystallizers, continuous, vacuum, evaporating crystallizers; The MSMPR crystallization model: crystal population balance; Precipitation.

Learning outcomes:

* the effect of the supersaturation on nucleation and crystal growth kinetics - classic and more recent theories for nucleation, crystal growth and agglomeration

* assess the effect of temperature, solvent composition, and supersaturation on the particle size distribution of the crystalline product and how this affects solid-liquid separation

UNIT.5: Drying of Solids: Instructional objectives: industrial example; Drying equipment: batch operation, continuous operation; Psychrometry: wet- bulb temperature, adiabatic--saturation temperature, moisture- evaporation temperature; Equilibrium- moisture content of solids; Drying periods: constant-rate drying period, falling- rate period; Dryer models: materials and energy balances for direct- heat dryers, belt dryer with through- circulation, direct- heat rotary dryer, fluidized- bed dryer.

Learning outcomes:

* understand the operations of drying equipments.

* draw the drying curve and drying rate curve for a wet solid being dried with air of fixed humidity and temperature

Text Books:

Units 2 to 5: 'Separation Process Principles', Seader, J.D. and Henley, EJ, 2Ed.Wiley India.

Unit 1: 'Bioseparations: Principles and Techniques' by B.Sivasankar, Prentice-Hall India.

BIO-1.2.4-Elective-III

B10-1.2.4 A -Elective-III (Industrial Biotech Products)

Objectives:

* To study the structure and functions of various fermentors and study indetail the production media preparation, inoculums preparation and sterilization methods.

* To study the production ethyl alcohol, vinegar, lactic acid , citric acid and amino acids using microbial fermentation processes.

* To study the production of alcoholic and non alcoholic beverages in detail and to study the production of antibiotics, vitamins and baker's yeast, microbial enzymes and co-enzymes in detail using modern fermentation techniques.

Outcome:

* Students will obtain vast knowledge in the fermentation technology to produce various industrially important bio products.

* Students will acquire knowledge in handling bioreactors and sterilization methods.

* Students can start small scale industries to produce bio products using fermentation techniques.

* As this subject gives advanced level knowledge in the production of industrial biotech products, the further improvement and advances can be achieved by research.

SYLLABUS

I: Fundamentals involved in the' production of industrial Microbial prod-ucts such as details of the Fermentors, Synthetic and natural medium, proces-sors, Sterilization methods, and innocuium preparation. A detailed study of 'Ethanol' production by fermentation, using black blinap molasses, aarchy sub-stance and glus\cosic like waste sulphate liquid purification methods of the fermented broth and production, of absolute ethyl alcohol. 2. - industrial microbial processes and source of industrial cultures.

Learning Outcomes:

On completion of this topic, the student will be able to learn - basic fundamentals involved in the fermentation process and microbial production of various products like ethanol etc

II: Materials for fermentative production of Vinegar, Lactic Acid, Citric Acid, and Amino acids. The method Involves selection of the particular strain of the micro-organism for Industrial Fermentation, process details and purification.

Learning Outcomes:

At the end of the course study, the student will be able to learn -the production of citric, lactic and vinegar production -Selection of starin for fermentation , process details and purification process.

III: Production of Alcoholic beverages with Beer, Brandy, Whisky and Wine. Baked goods, cheese and other dairy products.

Learning Outcomes:

On completion of this topic, the student will be able to learn -Production of alcoholic beverages and dairy products.

IV: Production of Antibiotics, Tetracyclines, Alkaloids Bakers yeast and Microbial Enzymes and Co-enzymes.

Learning Outcomes:

On completion of this topic, the student will be able to learn Antibiotic production like tetracyclines, Bakers yeast and enzymes.

V: Fermentative materials for producing vitamins, Products from plant cell Cultures, Non - alcoholic beverages (Coco, Coffee, Tea fermentation).

Learning Outcomes:

On completion of this topic, the student will be able to learn Fermentation materials like vitamins , cell culture products and alcoholic beverages.

Textbook:

"Industrial Microbiology" by Samuel C. Presscott and Cecil, G. Dunn; A McGraw - Hill Publication.

References:

1. "Industrial Mic~obiology" by L.E. Casida. Jr. Wiley Eastern Limited.
2. "Microbial Technology Vol. 1 and Vol. 2 by H.J. Peppler and D. Pulman (Academic Press).

B10-1.2.4 B -Elective-III (Pharmaceutical Biotechnology)

Objective: The main objective of this course is to contribute to improve human health by exploiting the potential biopharmaceutical research by

* Promoting research and development in the field of pharmaceutical biotechnology.

* Promoting interactions between academia, biotechnology and pharma companies within the field of pharmaceutical biotechnology to support creativity, innovations and facilitate the commercialization of scientific finding.

Outcome: At the end of course the students would have learnt about the * Promoting appropriate education and training for students in the field of pharmaceutical biotechnology

SYLLABUS

Introduction- Development of Drug and Pharmaceutical Industry, Therapeutic agents – their uses and economics, Regulatory aspects. Drug metabolism and Pharmacokinetics- Metabolism, Physico-chemical principles, radioactivity, Pharmaco kinetics action of drugs on human bodies.

Important Unit Processes and their applications: Bulk drug manufacturing, Types of reactions in bulk drug manufacturing and processes, Special requirements for Bulk Drug manufacture.

Manufacturing Principles: Wet granulation, Dry granulation or slugging, Direct compression, Tablet presses. Coating of tablets, capsules. Sustained action dosage. Forms- Parental solutions, oral liquids, injections, ointments. Various topical drugs and pharmaceuticals, Packaging- Packaging techniques, Quality management and GMP.

Pharmaceutical products and their control- Therapeutical categories such as laxatives, vitamins, analgesics, non-steroid contraceptives, antibodies and Biologicals- Hormones.

REFERENCE BOOK:

Remington's Pharmaceutical Sciences, Mark publishing and Co.

TEXT BOOKS:

Leon and Lachman et al- Theory and Practice of Industrial pharmacy.

Cooper and Gunn's – Dispencing Pharmacy.

B10-1.2.4 C -Elective-III (Agricultural Biotechnology)

Objective: Agriculture has been theorized to have become the dominant way of producing food since the Neolithic Revolution. Throughout the history of agriculture, farmers have inadvertently altered the genetics of their crops through introducing them to new environments and breeding them with other plants — one of the first forms of biotechnology. Agricultural Biotechnology is being used to address problems in all areas of agricultural production and processing. This includes plant breeding to raise and stabilize yields; to improve resistance to pests, diseases and abiotic stresses such as drought and cold; and to enhance the nutritional content of foods. Biotechnology is being used to develop low-cost disease-free planting materials for crops such as cassava, banana and potato and is creating new tools for the diagnosis and treatment of plant and animal diseases and for the measurement and conservation of genetic resources. Animal feeds and feeding practices are being changed by biotechnology to improve animal nutrition and to reduce environmental waste. Biotechnology is used in disease diagnostics and for the production of vaccines against animal diseases.

Outcome: Student gains fair knowledge clearly by coming to a conclusion that biotechnology is more than genetic engineering. Indeed, some of the least controversial aspects of agricultural biotechnology are potentially the most powerful and the most beneficial for the poor. In general we can say agricultural biotechnology as understanding, characterizing and managing genetic resources.

SYLLABUS

Introduction - Definition, classical vs modern approach, demand for biological resources, achievements, Nitrogen Fixation- Basic concepts, nif genes and their regulation, potential scope in crop improvement, Genetic engineering - aims of genetic engineering, techniques of gene manipulation, Transformation Techniques -Physical methods, agrobacterium, mediated transformation. Transgenics - Basic concept and essential steps of the process, some examples of transgenic plants, use of suitable promoters, gene silencing and measures to overcome it, commercial aspects of the technology. Molecular Markers - concept, SNPs, RAPD, RFLP, role in crop improvement and genome mapping, Molecular and biochemical basis, signalling pathways in the production of transgenic plants for fungal, bacterial and viral disease resistance; herbicide resistance, pest resistance, drought and other abiotic stress resistance, Plant as Biofactories - Concept, production of chemicals, pigments, perfume, flavors, insecticides, anticancer agents and other important compounds, molecular farming, use of plants for production of neutraceuticals, edible vaccines and other desired products, SCP - micro organisms, nutritional value, production of algal biornass, bio fertilizers and bio pesticides, mass cultivation of Rhizobium, AzatLibacter, Azospirillum, Mycorrhiza, bluegreen algae and Azolla.

Text books:

1. "Agricultural Biotechnology" by Arie Altman, Marcel Dekker, Inc. (2001)
2. "Agricultural Biotechnology", by S.S.Purohit, Agro Bios (India)

Reference book:

1. "Molecular Biotechnology Principles and Applications of Recombinant DNA", by Bernard R. Glick and Jack J. Pasternak,. ASM Press

BIO-1.2.5- ELECTIVE-IV

BIO-1.2.5 A-ELECTIVE-IV (Corrosion Engineering-II)

Common for M.Tech (Chemical, MPE, IPCE, CACE & Biotechnology)

Objectives:

* To enable the principles of corrosion, common corrosion forms, uniform, galvanic, pitting, inter granular, crevice, dezincification, stress corrosion, corrosion fatigue, hydrogen embrittlement corrosion control methods, and material selection to reduce corrosion cost.

* To enable the ability to understand electrochemical fundamentals

* To enable the ability to understand corrosion preventing methods

Outcome:

* The student would know application of weight loss method

* The student would know application of cathodic protection, anodic ptotection

* At the end of this course, the student would know effective surface preparation of specimen can be done

* After completion of this course, the student would understand the causes and the mechanisms of various types of corrosion, including uniform corrosion, galvanic corrosion, crevice corrosion, pitting corrosion, intergranular corrosion.

* The student would know application of Corrosion Processes and Evans Diagrams and application of electroplating, coatings and importance of inhibitors.

SYLLABUS

Corrosion in selective environments: Marine, Acids (Sulfuric acid, Hydrochloric acid, Nitirc acid, Phosphoric acid) Biological and industrial gases (SO_2H_2S).

* Able to understand corrosion and its mechanism in marine atmosphere.

* Able to understand corrosion in acidic media like Sulfuric acid, Hydrochloric,etc.

Corrosion Testing - Purposes, Materials and specimen. Surface preparation, Measuring and weighing , Exposure Techniques - duration, Planned - Interval Tests, Aeration, cleaning specimens after exposure, Temperature, Standard expression for corrosion rates - Galvanic Corrosion, Erosion Corrosion, crevice Corrosion, Intergranular corrosion, test for stainless steels, warren test pitting, stress corrosion, Paint tests, Sea Water tests, Presenting and summarizing data - Nomo graph for corrosion rates and interpretation of results.

* Able to understand the importance of surface preparation.

* Able to understand the application of Standard expression for corrosion rates using weight loss method.

* Able to understand the application of different corrosion tests.

Cathodic and anodic protection, surface preparation for coatings and chemical conversions: Degreasing, Descaling , Polishing - Anodized coating : anodizing oxidizing, chromate coating, phosphate coatings - Metallic coatings : Hot dipping, cementation, vapor deposition of metallic coating; Sprayed coatings: flame spraying plasma spraying, Galvanizing - Electroplating : Nickel & chromium coatings, chromizing.- Organic coatings : paints, enamels, lacquers, resin mixtures.

* Able to understand the application of Cathodic and anodic protection.

* Able to understand the uses of Degreasing, Descaling , Polishing.

* Able to understand the importance of Hot dipping, cementation, vapor deposition of metallic coating. Linings, laminates, reinforced plastic, fibre glass - Corrosion inhibitors: mechanism of inhibition, recirculating of water of water systems.

* Able to understand the importance of Corrosion inhibitors and mechanism of inhibition.

Measurement and testing of preventive coatings; Thickness and Resistance tests for anodized, Painted, electroplated surfaces using polarization resistance, Linear polarization, curve fit analysis and Electrochemical impedance spectroscopy.

* Able to understand the Thickness and Resistance tests.

* Able to understand the linear polarization and curve fit analysis.

Reference books :

1. Mars G.Fontana - Corrosion Engineering

2. Burns, R.M., Bradley, W.W., 'protective coatings for Metals.' Chapters 2 to 18.

Reference Books :

Corrrosion Volumes 1 & 2 by L.L. Shrier, Newnes - Butter-worths, London.

BIO- 1.2.5 B - Elective-IV (Energy Engineering-II)

Common for M.Tech (Chemical, MPE, IPCE, CACE & Biotechnology)

Course objectives:

1. The student is provided with the fundamentals of renewable energy processes.

2. Basic information to comprehend the various non-conventional energy systems would be illustrated to the student.

3. Various ways of obtaining energy from ocean can be demonstrated to the student.

4. The methods of energy conservation and the opportunities for conservation would be emphasized.

5. Economics involved in the energy production processes would be enumerated to the student.

Course Outcomes:

1. Methods to be adopted to utilize biomass as an important energy source

2. Application of thermodynamics to obtain energy from various sources

3. Possible mechanism to draw energy from wind and other natural resources

4. Knowledge about energy conservation and storage

5. Emerging technologies to produce energy such as thermionics, thermoelectricity etc.

SYLLABUS

Fundamentals of energy science and technology: Introduction – Energy, economy and social development – Oil crisis of 1973 – classification of energy sources – consumption trend of primary energy resources – importance of non-conventional energy sources – energy chain – common forms of energy – advantages and disadvantages of conventional energy sources – salient features of non-conventional energy sources – energy densities of various fuels – environmental aspects of energy – The United Nations Framework Convention on Climate Change – Energy-environment-economy – World energy status – energy scenario in India. Energy conservation and efficiency: Introduction – important terms and definitions – important aspects of energy conservation – global efforts, achievements and future planning – energy conservation/efficiency scenario in India – energy audit – energy conservation opportunities – cogeneration – combined cycle plants. Energy storage: Introduction – necessity of energy storage – specifications of energy storage devices – energy storage methods.

Learning outcomes:

1. The student can identify the ways and means of conservation of energy once the student completes learning this unit.

2. The student can appraise the necessity of energy storage and recommend the methods for energy storage at the end of the unit.

Wind energy: Introduction – origin of winds – nature of winds – wind turbine siting – major applications of wind power – basics of fluid mechanics – wind turbine aerodynamics – wind turbine types and their construction – wind energy conversion systems – wind-diesel hybrid system – effects of wind speed and grid condition – wind energy storage – environmental aspects – wind energy program in India.

Learning outcomes:

1. By studying this unit, the students will be able to predict where the wind power plants can be located.

2. At the end of this unit, the students can recommend appropriate technology for obtaining geothermal energy in a given situation.

Biomass: Introduction – Photosynthesis process – usable forms of biomass, their composition and fuel properties – biomass resources – biomass conversion technologies – urban waste to energy conversion – biomass gasification – biomass liquefaction – biomass to ethanol production – biogas production from waste biomass – energy farming. Geothermal energy: Introduction – applications – origin and distribution of geothermal energy – types of geothermal resources – analysis of geothermal resources – exploration and development of geothermal resources – environmental considerations – geothermal energy in India.

Learning outcomes:

1. After completing this unit, the students will be able to choose appropriate biogas plant for a given location and able to provide dimensions of the same.

2. At the end of this unit, the students will be able to recommend a process for utilizing the biomass for a given application.

Ocean Energy: Introduction: Tidal energy – wave energy – ocean thermal energy. Small hydro resources: Introduction – advantages and disadvantages of small hydro schemes – layout of a micro-hydroscheme - water turbines – turbine classification, characteristics and selection – generators – present status.

Learning outcomes:

1. At the end of this unit, the students can recommend appropriate technology for obtaining energy from ocean in a given situation.

2. Suitable scheme for generating electricity from small hydroresources can be suggested by the student after the completion of this unit.

Emerging technologies: Introduction – fuel cell – hydrogen as energy carrier. Miscellaneous non-conventional energy technologies: Introduction – magneto hydrodynamic power conversion – thermoelectric power generation – thermionic power conversion. Financial and economic evaluation: Introduction – basic terms and definitions – calculations for the case of single payment – calculation for uniform series of payments – calculations for uniform gradient series of payments – calculations for geometric gradient series of payments –

effect of inflation on cash flows – comparative economic evaluation of alternatives – effect of depreciation and tax on cash flow.

Learning outcomes:

1. New technologies for obtaining energy from various renewable sources can be evaluated by the student.

2. Economic factor in the energy production by various technologies can be compared by the student at the end of this unit.

Text book:

Non-Conventional Energy Resources by B.H. Khan, 3/e, McGraw Hill (2017).

Reference book:

Fundamentals of Renewable Energy Processes by Aldo V. Da Rosa. Elsevier (2005).

BIO- 1.2.5 C - Elective-IV (Reaction Engineering-II)

Common for M.Tech (Chemical, MPE, IPCE, CACE & Biotechnology)

Syllabus

UNIT - I : Laboratory Reactors - Interpretation of Experimental Data - Interpretation of Laboratory Kinetics Data - Homogeneous and Heterogeneous Laboratory Reactors. Calculation of Global Rate - The structure of Reactor Design. (Scope: Chapter 12 of J.M Smith 3rd Edition)

UNIT - II : Design of Heterogeneous Catalytic Reactors Isothermal and Adiabatic Fixed Bed Reactors Non-isothermal, Non-adiabatic Fixed Bed Reactors. (Scope: Chapters 13.1 - 13.9 of J.M Smith 3rd Edition)

UNIT - III : Design of fluidized bed Reactors - Two -Phase Fluidized Bed model - Operating characteristics - Slurry Reactors - Trickle - Bed Reactors - Optimization. (Scope: Chapter 13.10 - 13.13 of J.M Smith 3rd Edition.)

UNIT - IV : Fluid - Solid Noncatalytic Reactions - Design concepts - Single Particle Behavior - Reactor Models. (Scope: Chapter 14 of J.M Smith 3rd Edition)

UNIT - V : Short notes from the portions of all the above four units. Four bits are to be answered out of 7 bits (Not more than 2 bits to be given from any one Unit).

Text Book:

Chemical Engineering Kinetics by J.M Smith, McGraw - Hill Book Company , 1980, 3rd Edition.

BIO 1.2.6: AUDIT COURSE -2

BIO 1.2.6 A : DISASTER MANAGEMENT (Audit Course -2)

Common for M.Tech (Chemical, MPE, CACE, IPCE, Biotechnology)

Introduction to Disaster: Definition, Factors And Significance; Difference Between Hazard And Disaster; Natural And Manmade Disasters: Difference, Nature, Types and Magnitude.

Repercussions Of Disasters And Hazards: Economic Damage, Loss of Human And Animal Life, Destruction Of Ecosystem. Natural Disasters: Earthquakes, Volcanisms, Cyclones, Tsunamis, Floods, Droughts And Famines, Landslides And Avalanches, Man-made disaster: Nuclear Reactor Meltdown, Industrial Accidents, Oil Slicks And Spills, Outbreaks Of Disease And Epidemics, War And Conflicts.

Disaster Prone Areas in India Study Of Seismic Zones; Areas Prone To Floods And Droughts, Landslides And Avalanches; Areas Prone To Cyclonic And Coastal Hazards With Special Reference To Tsunami; Post-Disaster Diseases And Epidemics

Disaster Preparedness And Management Preparedness: Monitoring Of Phenomena Triggering A Disaster Or Hazard; Evaluation Of Risk: Application Of Remote Sensing, Data From Meteorological and Other Agencies, Media Reports: Governmental And Community Preparedness.

Risk Assessment Disaster Risk: Concept and Elements, Disaster Risk Reduction, Global and National Disaster Risk Situation. Techniques of Risk Assessment, Global Co-Operation In Risk Assessment and Warning, People's Participation In Risk Assessment. Strategies for Survival

Disaster Mitigation Meaning, Concept and Strategies Of Disaster Mitigation, Emerging Trends In Mitigation. Structural Mitigation And Non-Structural Mitigation, Programs Of Disaster Mitigation In India.

REFERENCES:

1. R. Nishith, Singh AK, "Disaster Management in India: Perspectives, issues and strategies "'New Royal book Company.

2. Sahni, PardeepEt.Al. (Eds.)," Disaster Mitigation Experiences and Reflections", Prentice Hall Of India, New Delhi.

3. Goel S. L., Disaster Administration And Management Text And Case Studies",Deep & Deep Publication Pvt. Ltd., New Delhi.

BIO 1.2.6 B: ENTREPRENEURSHIP (Audit Course -2)

Common for M.Tech (Chemical, MPE, CACE, IPCE, Biotechnology)

Unit -I : Basic Concepts of Management:Management :- Definition, Nature and Importance ; Functions of the Management; Levels of Management; F.W Taylor's Scientific Management; Henry Fayol's Principles of Management.

Unit-II : Forms of Business Organizations: Introduction, Types of Business organizations: Private Sector- Individual Ownership , Partnership, Joint stock companies and Co-Operative organizations; Public sector- Departmental Organizations, Public Corporations and Government Companies; The Joint sector Management.

Unit-III Production and operations Management: Plant location- Factors to be considered in the selection of Plant location; Break - even analysis-Significance and managerial applications; Importance of Production Planning and Control and its Functions; Human Resource Management and Functions of Human Resource Manager (in brief); Functions of Marketing; Methods of Raising Finance.

Unit-IV : Entrepreneurship: Definition, Characteristics and Skills, Types of Entrepreneurs, Entrepreneur vs. Professional Managers, Growth of Entrepreneurs, Nature and Importance of Entrepreneurs, Women Entrepreneurs, Problems of Entrepreneurship.

Unit-V : Entrepreneurial Development and Project Management: Institutions in aid of Entrepreneurship Development, Idea generation: Sources and Techniques; Stages in Project formulation; Steps for starting a small enterprise - Incentives for Small Scale Industries by Government.

Text Books:

1. Sharma, S.C, and Banga, T.R., Industrial Organization & Engineering Economics, Khanna Publishers, Delhi, 2000.

2. Vasant Desai, The Dynamics of Entrepreneurial Development and Management (Planning for future Sustainable growth), HImalayan Publishing House, 2018.

Reference Books:

1. Aryasri, A.R., Management Science, McGraw HIll Education (India Private Limited, New Delhi 2014.

2. Sheela, P. and Jagadeswara Rao, K., Entrepreneurship, Shree Publishing House, Guntur,

III Semester

BIO -2.1.1- Elective-V

BIO -2.1.1 A- Elective-V (Enzyme Engineering)

Course Objectives:

1. Understand the importance of enzymes, their classification, sources, extraction and purification of enzymes.

2. Understand the mechanism of enzyme action, their kinetics and types of enzyme inhibitions.

3. Study the various types of Inhibitions.

4. Study the various sources of Enzymes.

5. Learn the methods of extraction and purification.

6. Know about the advantages of immobilization of enzymes, methods of immobilization.

7. Acquaint with the applications of enzymes in solution as well as immobilized enzymes.

Course Outcomes:

At the end of the course, the student will be able to

1. Able to appreciate the importance of enzymes and know about their sources and extraction.

2. Analyze the kinetics of enzyme reactions.

3. Identify the type of enzyme inhibition.

4. Assess the sources of enzymes.

5. Describe the various methods of extraction and purification of enzymes.

6. Differentiate different immobilization techniques.

7. Recall different enzymes and their applications used in various industries.

SYLLABUS

INTRODUCTION TO ENZYMES: Importance of enzymes in Biotechnology, Nomenclature and classification of enzymes, enzyme specificity, coenzymes, enzyme units and turnover number, factors affecting enzyme activity (pH, temperature, chemical agents and irradiation), mechanism of enzyme catalysis.

Learning Outcomes:

1) List the importance of enzymes

2) Differentiate the enzymes on the type of reaction they catalyze.

ENZYME KINETICS: Simple enzyme kinetics, Michaelis-Menten equation, Quasi-steady-state kinetics and Briggs –Haldane approach, Evaluation of parameters in Michaelis-Menten equation.

Learning Outcomes:

1) Study the enzyme kinetics.

2) Evaluate the parameters of Michaelis-Menten equation.

ENZYME INHIBITION: Inhibition of enzyme reactions-Competitive, non-competitive, uncompetitive, substrate and product inhibition, deactivation kinetics, derivations of M-M form of equations for various inhibitions.

Learning Outcomes:

1) Evaluate the type of inhibition for a given reaction.

2) Assess the inhibition.

SOURCES OF ENZYMES: Plant, animal and microbial sources and their advantages and disadvantages.

Learning Outcomes:

1) Investigate the various sources of enzymes.

2) Apply the appropriate source of enzyme for maximum production.

ENZYME EXTRACTION AND PURIFICATION: Methods of production of enzymes, cell disruption, extraction of enzymes, purification of enzymes.

Learning Outcomes:

1) Justify the extraction methods to use.

2) Discuss the purification methods of enzymes.

ENZYME IMMOBILIZATION: Methods of immobilization- physical and chemical (covalent binding, cross-linking, adsorption, matrix entrapment and microencapsulation), advantages and disadvantages of different immobilization techniques, kinetics of immobilized enzymes, mass transfer effects in immobilized enzyme systems.

Learning Outcomes:

1) Recommend the type of immobilization method for the production.

2) Study the kinetics of immobilized enzymes.

ENZYME APPLICATIONS: Application of enzymes in various industries (brewing, detergent, starch, baking, dairy, food, leather, wool, animal feed, textile, paper and pulp, pharmaceutical).

Learning Outcomes:

1) Construct the various enzymes used in the industries.

2) Apply the enzymes produced in industries.

APPLICATION OF IMMOBILISED ENZYMES: Immobilized enzyme processes, HFCS, production of amino acids, antibiotics.

Learning Outcomes:

1) Sort the different immobilized enzymes used in various industries.

2) Apply the immobilized enzymes in industries.

Text books:

1. Enzyme Technology by Chaplin, M.F and Bucke, C Cambridge University Press,1990.

2. Enzyme Technology 2nd Ed S.Shanmugan, T.Sathish Kumar, M.Shanuga Prakash I.K.International Publishing House Pvt. Ltd.

3. Biochemical Engineering Fundamentals. J.E.Bailey and David F Ollis 2nd Edition 1986, McGraw Hill.

References books:

1. Enzyme Engineering. L.B.Wingard, J.Inter Science, New York 1972.

2. Enzymes Trevor Palmer East West Press Pvt. Ltd. New Delhi.

BIO -2.1.1 B- Elective-V (Stem Cells in Health Care)

Stem cell basics: Unique properties of stem cells, embryonic stem cells, adult stem cells, umbilical cord stem cells, similarities and differences between embryonic and adult stem cells, properties of stem cells – pluripotency, totipotency, multipotency,

Embryonic stemcells: Invitro fertilization, human embryonic stem cells, blastocyst, inner cellmass, growing ES cells in laboratory, laboratory tests to identify ES cells, stimulating ES cells for differentiation, properties of ES cells, human ES cells, monkey and mouse ES cells,

Adult stem cells: Somatic stem cells, test for identification of adult stem cells, adult stem cell differentiation, trans-differentiation, plasticity, different types of adult stem cells,

Stem cell in drug discovery and tissue engineering: Target identification, manipulating differentiation pathways, stem cell therapy Vs cell protection, stem cell in cellular assays for screening, stem cell based drug discovery platforms, drug screening and toxicology,

Genetic engineering and therapeutic application of stem cells: Gene therapy, genetically engineered stem cells and animal cloning (transgenic animals), biomarkers in cancer, therapeutic applications in parkinson's disease, neurological disorder, limb amputation, heart disease, spinal cord injuries, diabetes, matching the stem cell with transplant recipient, HLA typing, Alzheimers disease, spinal cord injuries, tissue engineering application, production of complete organs – kidney, eyes, heart, brain.

Text books:

1. "Stem Cells, Human Embryos and Ethics: Interdisciplinary Perspectives" by Larstnor, Springer, 2008

2. 'Handbook of Stem Cells', Volume-1, by Robert Paul Lanza, Gulf Professional Publishing, 2004

Reference books:

1. "Embryonic Stem cells"by Kursad and Turksen. 2002, Humana Press.

2. "Stem Cell and Future of Regenerative medicine by Committee on the Biological and Biomedical Applications of Stem cell Research", 2002, National Academic Press.

BIO -2.1.1 C- Elective-V (Environmental Biotechnology) (Common with IPCE)

Objectives:

* Student to learn and understand environmental problems locally as well as global issue and consequencies.

* To learn about xenobiotics and their effect on ecosystem. To learn about biodiversity available.

* To learn about alternative and noval methods like biosorption of metals and bioleaching.

Outcome:

* Students have enough skills to identify the environmental problems and control measures.

* Students are in a position to plan to treat various industrial effluent using biotechnological methods

SYLLABUS

Unit-1 Ecosystem : Environment, types of Environment, Environment and Development, Environmental management, environmental education, principles of ecology, ecosystems, types of ecosystems, ecosystem structure and functioning, food chains, food webs, Ecological pyramids, nutrient cycling, microbial associations.

Learning Outcomes:

On completion of this topic, the student will be able to

i. Understand various types of ecosystems, association of components of ecosystems ii. Have an idea about food chains, food webs, ecological pyramids etc.

Unit-2 Pollution control Source, effects and control aspects of various pollutants: Air (Particulate matter, SOx, NOx, COx, CHx, noise), water (primary, secondary and advanced treatment techniques), solids (recycling, incineration and bioconversion) Global environmental problems: global warming, ozone depletion and acid rain. Industrial effluent treatment: case studies of paper and pulp, tannery, pharmaceutical, fertilizer and petroleum industries.

Learning Outcomes:

On completion of this topic, the student will be able to

i. Have an ability to discuss various types of pollution & its control. ii. Identify Global environmental problems and treatment if necessary.

Unit-3 Biological Activities in the Environment Biodegradation of Xenobiotics: Xenobiotic compounds in the environment, persistent compounds, degradation mechanisms.

Bioremediation: Bioremediation by microorganisms, bioremediation process and technologies, measuring bioremediation in the field, monitoring and efficacy of bioremediation.

Biosorption of metals: Microorganisms and metal absorption, factors affecting bioabsorption, bioreactors and bioabsorption, phytoremediation.

Bioleaching: Types of bioleaching, advantages and disadvantages of bioleaching, methods for bioleaching.

Learning Outcomes:

On completion of this topic, the student will be able to

i. Understand various biological activities like biodegradation, bioleaching, biosorbtion of metals, bioremediation etc, occurring in the Environment. ii. advantaged & disadvantages of above biological activities.

Unit-4 Biodiversity: Levels of biodiversity, value of biodiversity, global biodiversity, hotspots of biodiversity, threats to biodiversity, conservation of biodiversity.

Learning Outcomes:

On completion of this topic, the student will be able to

i. Have an idea of Biodiversity, its value & levels. ii. Understand threats & hotspots and conservation of biodiversity.

Unit-5 Environment and energy: Biomass sources, biomass production and utilization for energy, biomass conversation routes, energy crops, biofuels, biodiesel, hydrogen Production, conservation of energy. Biofertilizers, biopesticides, biofilters, biosensors, biopolymers and bioplastics.

Learning Outcomes:

On completion of this topic, the student will be able to

i. Have an ability to understand Environment & its energy conservation. ii. To identify & utilize biofertilizers, biopesticides, biosensors, biofilters, biopolymers & bioplastics, etc

TEXT BOOKS:

1. Environmental Pollution Control Engineering by C. S. Rao. Wiley Eastern Limited

2. Waste Water Treatment: Rational Methods of design and industrial practices by M. Narayana Rao and Amal K. Datta. Oxford & IBH publishing Co. Pvt. Ltd.

3. Environmental Biotechnology: Basic concepts and applications by Indu Shekhar Thakur. 1. K. International Pvt. Ltd.

REFERNCE BOOKS:

1. Microbial Ecology: A conceptional approach by Lunch, 1. M. Oxford Black N.S.D.

2. Environmental Biotechnology by Geetha Bali. APH Publishing Corporation.

BIO-2.1.2: Elective –VI (Open Elective)

BIO-2.1.2 A : Elective-VI (Nanotechnology)

Common for M.Tech (Chemical, MPE, CACE, IPCE, Biotechnology)

Objectives:

Nanotechnology may be treated as Green technology. It is one of the most advanced technologies now-a-days. It leads to have revolutionary changes in the fields of medical, Bio-medical, and fabrication of materials. Technologists are able to prepare ageless materials with the help of nano-techniques. Main objectives of the subject nanotechnology are :

1. To define green technology properly
2. To expose the students with new techniques of the nanotechnology.
3. To make them to learn the importance of quantum technology
4. To learn the procedure ageless materials to avoid wear-tear.
5. To learn the importance of nano –robots, machines
6. To know about the latest microscopes such as SEM, TEM
7. To know the importance of nanotechnology in the dawn of optical instruments

Outcome:

1. Application of nanotechnology in the development of energy
2. Application of nanotechnology in the development of solar panels, Fuel cells
3. Knew the importance of atoms manipulation
4. Knew that the applications of nanoparticles in the development of DVD, LEDs etc.
5. Biomedical applications in terms of preparing artificial, drug delivery, encapsulation, addition to that pharmaceuticals.

SYLLABUS

1. Introduction to nanotechnology, molecular and atomic size, surface and dimensional spaces. Molecular nanotechnology: atoms by inference, electron microscopes, nanomanipulator, nanotweezers, atom manipulation, nanodots, nanolithography.

Learning Outcomes:

* Define the term nanotechnology to understand in a better way the subject basics

* Demonstrate the different types of Electron Microscopes and their uses.

2. Nanopowders and nanomaterials: preparation, plasma arcing, chemical vapor deposition, sol-gels, electrodeposition, Ball milling, applications. Carbon nanotubes: types, formation, assemblies, purification, properties and uses.

Learning Outcomes:

* Summarize the nanomaterials used for the preparation of nanopowders

* Apply and selection of the different methods to prepare nanopowders

* Classify the carbon nanotubes and purification process.

3. Molecular mimics: Catenanes and rotaxanes, various molecular switches, synthesis of rotaxanes and catenanes, molecular computers, chemical rotors, prodders, flippers, atom shuttles, actuators, contacts.

Learning Outcomes:

* Categorize the molecular switches and synthesis of rotaxane and catenanes

* Examine the function of molecular computers

4. Nanobiometrics: Lipids as nano-bricks and mortar, self – assembled monolayers, proteins, 3-D structures arising from amines acids, nanoscale motors, Biological Computing, ion channels as sensors, Information in DNA structure, using DNA to build nano-cubes, hinges, smart glue, wire template.

Learning Outcomes:

* Evaluate the importance of nanobiometrics as self-assembled monolayers and nanoscale motors.

* Explain the process of biological computing and using DNA as hinges, smart glue, wire template

5. Optics, photomics and solar energy: Properties of light and nano technology, Interaction of light and nanotechnology, Nanoholes and photons, Imaging, New low cost energy efficient windows and solar absorbers based on nanoparticles, Photonic crystals, surface wave guides and control of light paths.

Learning Outcomes:

* Discuss about the optics, photomics and solar energy with reference to light properties.

* Chose a technique using nanoparticles to manufacture solar absorber, photonic crystals and change the light path.

6. Nanoelectrons: birth of electrons, semiconductors, transistor, integrated circuits, the tools of micro and nanofabrication, quantum electronic devices, quantum information and quantum computers, experimental implementations of quantum computers.

Learning Outcomes:

* Appraise different phased in the development of nanoelectornics tools.

* Construction of quantum computers and its experimental implementations.

7. Future applications: microelectomechanical systems, nano-robots , ageless materials, invisible mending of atomic dislocations inside damaged materials, nanomechanics and nanoelasticity, nanoparticle coatings, nanoelectronic and magnetic devices and new computing systems, optoelectronic devices, environmental applications.

Learning Outcomes:

* Assess the future application of nanotechnology in various fields

* Create new tools with nanotechnology to prepare new devices

Text-book:

1. M.Wilson, K.Kannangara, G. Smith, M. Simmons and B. Ragues, Nanotechnology, Overseas press (India) Private Ltd; New Delhi, 2005.

Reference books:

1. G. Ali Mansoori*, Principles of Nanotechnology, World Scientific Publishing Company, 2005.

2. G. Timp, Nanotechnology, Springer-Verlag, Network, 1999.

3. P. Poole and F.J. Owens, Introduction to Nanotechnology, John Wiley, 2003.

4. D.Ratner and M.Ratner, Nanotechnology: A Gentle Introduction, Pearson Education,2003.

5. B. Bhusan, Handbook of Nanotechnology, Springer, 2004

BIO-2.1.2 B: Elective-VI (POLLUTION CONTROL)

Common for M.Tech (Chemical, MPE, CACE, IPCE, Biotechnology)

Objectives:

* Focus on classification of air pollutants, water pollutants and solid waste –causes, effects and control methods, need of environmental Legislation.

Outcome:

* Enables the students to adopt the preventive measures for the control of air pollutants, waste water treatment methods, and solid waste management methods in domestic, municipal waste.

* Enables the students to understand the control measures of pollutants emitted from different industries like Paper and pulp, fertilizer, sugar and alcohol, petrochemical and petroleum refinery, pharmaceutical and metal finishing industries.

SYLLABUS

Kinds of ecology, environment and ecofactors, types of ecosystems, sulphur cycles, phosphorous cycle, Nitrogen cycle and hydrological cycle Sources for water, Air and solid pollution, Analysis and effects of the pollutants in air, in water, Solids(particulate matter, SOx, NOx, Cox, CHx). Limits of pollutants, Environmental Legislation.

Control aspects of various pollutants Air (Particulate matter, SOx, NOx, COx, CHx, Noise) water (primary, secondary and territory treatment techniques) Solids (recycling, incineration,bio-conversion).

Case studies of Industries: Paper and pulp, petrochemical, Fertilizer, Pharmaceuticals, tannery, sugar and alcohol industries, metal finishing industries.

Learning Outcomes:

* Describe different ecosystems

* Explains the bio-geochemical cycles

* classify the main types of pollution and their effects

* Describe the sources of pollution and their characteristics

* Describe the effects of air and water pollution on the environment and on human health

* Explain the importance of Environmental Legislation for pollution prevention and control

* Evaluate the preventive measures for the control of air pollutants – SPM

* Select the most appropriate technique to control SOx, NOx, COx, CHx

* Describe the primary, secondary and territory treatment techniques waste water treatment methods

* Propose control measures of pollutants emitted from different industries like paper and pulp

* Plan to select most appropriate technique to control pollutants from petrochemical and refineries

* Explain the control aspects of pollutants from Fertilizer, Pharmaceuticals

* Elucidate the control aspects of pollutants from tannery, sugar and alcohol industries, metal finishing industries

Text books:-

1. S.P.Mahajan., Pollution control in process Industries, Tata McGraw hill publishing company.

2. Arcadio P. Sincero and Georgia Sincero., Environmental Engineering

3. Environmental Pollution Control., by C.S.Rao, wiely eastern ltd.

BIO-2.1.2 C: Elective-VI (Corrosion Engineering)

Common for M.Tech (Chemical, MPE, CACE, IPCE, Biotechnology)

Course Objectives:

* Basic aspects of electrochemistry relevant to corrosion phenomena,

* Importance and forms of corrosion.

* Knowledge on corrosion rate expressions and measurement techniques.

* Basic knowledge on remedial measures for corrosion.

Course Outcomes:

At the end of the course, the student will be able to

* Identify various forms of corrosion.

* Determine corrosion rates for metals from their polarization curves

* Analyze corrosion rate characteristics from electrochemical impedance spectroscopy

* Select suitable corrosion resistant coatings, oxide layers for various applications

SYLLABUS

Introduction and scope: Corrosion definition, wet and dry corrosion, mechanism, electro-chemical principles and aspects of corrosion, Faradays laws, resistance, specific resistance, conductance, specific conductance, transport numbers, ionic mobility, corrosion rate expressions, calculation of corrosion rates, thermodynamic aspects of corrosion, equilibrium potential, Nernst equation for electrode potential, EMF series, over voltage, application of Nernst equation to corrosion reactions, Polarisation and corrosion potentials: References electrodes for corrosion measurements, types of polarisation, concentration, activation and resistance polarizations, Tafel constant, Evans diagrams, anodic control, cathodic control, mixed control, Pourbaix-diagram for Fe-H_2O system, Various forms of corrosion: Uniform attack, galvanic corrosion, crevice corrosion, pitting corrosion, intergranular corrosion, selective leaching (dezincification), cavitation damage, fretting corrosion, erosion corrosion, and stress corrosion and remedial measures, Prevention techniques: Modification of the material by alloying, appropriate heat treatment, chemical and mechanical methods of surface treatment, metallic, non-metallic linings, inhibitors, passivity, Cathodic protection and anodic protection.

TEXT BOOKS:

1. 'Corrosion Engineering' by Mars G. Fontana, Tata McGraw Hill Publishing Company, New Delhi

2. 'Corosion and Corrosion Control' by H.H.Uhllg, John Wiley & Sons Inc., America

REFERENCE BOOKS:

1. 'Electrochemistry' by Samuel Glasstone, Litton Educational Publishing Company

2. 'Electrochemistry, Principles & Applications' by Edmond C.Potter, Cleaver Hume Press Limited.